FOURTEENTH ANNUAL REPORT

of

Pasture Research

in the

Northeastern United States
State College, Pennsylvania

1950

1950

Fourteenth Annual Report

of

Pasture Research

in the

Northeastern United States

U. S. Regional Pasture Research Laboratory
State College, Pennsylvania

Division of Forage Crops and Diseases
Division of Soil, Management and Irrigation
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture
and
The Agricultural Experiment Stations
of the
Twelve Northeastern States
Cooperating

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Copies of this report were sent to all organizations involved in the development of the present pasture research program in the twelve Northeastern States and in addition to some institutions outside the Region where grassland research is a major interest.

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The Report is prepared primarily for the official use of forage crop research workers in the Region and since it is mimeographed in limited numbers, it is not available for general distribution to individuals outside the Region.

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REPORT

OF

PASTURE RESEARCH

IN THE

TWELVE NORTHEASTERN STATES

FOR THE CALENDAR YEAR 1950

INTRODUCTION

Within the past few months a national grasslands program has been launched as a joint undertaking of Land Grant Institutions and the United States Department of Agriculture. It is the hope of the sponsors that this campaign will help bring about more effective use of grasses and legumes in a sustained high level production of food and fiber on farms and ranches. Implementation on the farm will involve effective use of grasses and legumes in crop rotation, better pastures through seeding, fertilization, management and utilization, and in some cases conversion to grasslands of acreages that can best be used in that way.

The Northeastern Region has already made substantial and gratifying progress toward raising grass crops to the dignity that so rightfully belongs to them, but it would be dangerous to rest on laurels already won. We still have much to do both in extension and research. Have we stressed sufficiently the value of diversification of species in the management of grasslands? Red clover and timothy for meadows and Kentucky bluegrass and white clover for pastures make up the total grasslands on many farms and it would be difficult to get along without these valuable crops. Nevertheless the introduction on these same farms of such crops as orchard grass and Ladino clover, alfalfa and bromegrass, Sudan grass or millet and in some cases Birdsfoot trefoil, would, under proper management, provide more continuous grazing and help keep the barn or silo filled as well as provide greater variety in animal diet. We are in need of developing more effective and at the same time practical methods of preserving forages while they are still in a stage of growth acceptable and highly nutritious to animals. Highly nutritious pastures or other high quality forage can supply a large portion of an adequate and nutritious diet for farm animals and correspondingly reduce the need for grains or other more costly concentrates. The amount of fertilizer generally applied to grasslands is still woefully inadequate. There is evidence that the excess fertilizer applied on some farms to cash crops could be diverted profitably to grass crops. We have just begun a concerted effort to breed improved varieties of forage crops. For forage crops, methods are still to be developed that will guarantee original purity and provide for increase of improved varieties to make adequate seed supplies available. Other unsolved problems and interesting fields for exploration might be mentioned, but at the moment we are primarily concerned with recording briefly the progress that has been made in forage crop research in the twelve northeastern states during 1950.

This fourteenth annual report follows the plan of those issued in recent years. Part I is concerned with cooperative projects, Part II with Laboratory projects and Part III with state projects. A list of publications originating in the Region concludes the Report.

Personnel changes at the Laboratory during 1950 included the resignations of Dr. K. W. Kreitlow to become senior pathologist with the Division of Forage Crops and Diseases, Beltsville, Maryland and Mrs. Patricia A. Altieri, John Felty, Mrs. Hilda Heinly, A. G. Lueck, and Jim P. Trimble to accept other appointments. Dr. Joseph H. Graham who recently completed his graduate studies at North Carolina State College was appointed pathologist. Henry W. Indyk of New Jersey, Wallace H. Orgell of Iowa, H. P. Binger of New York and John Fawkes of Pennsylvania, all graduate students, were appointed as part time agents to assist in soil, plant climate, and chemical studies.

During the year a plan was developed by The Pennsylvania State College whereby part time assistants with the Pasture Laboratory who are qualified for admission to the Graduate School may be accorded the privileges usually extended to graduate assistants with the College, including remission of fees. This arrangement has several rather obvious advantages for the Laboratory in carrying on its research program and the Laboratory wishes to say thank you to The Pennsylvania State College for the friendly hand thus extended.

A collaborators' meeting was not held in 1950. Two regional technical committees, forage crops and soils, held meetings during the year and distributed reports to the conferees. A home and home visit during the summer was arranged by the forage crop breeders located at State College, Pennsylvania and Ithaca, New York, primarily for the purpose of inspecting plant materials and discussing plans. Plant climate studies regional in scope were considered at another conference held late in summer at the Pasture Laboratory.

COOPERATIVE RESEARCH

Title: PROJECT NE-10 - Adaptation, Management and Utilization of Forage Crops in the Northeast.

Leader: H. R. Albrecht, Chairman, Technical Committee

Cooperators: Connecticut, Delaware, Maine, Massachusetts, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, West Virginia Agricultural Experiment Stations and Pasture Research Laboratory.

Subproject 1 - The evaluation of forage crops, varieties, and strains for their use and adaptation in the Northeast.

The seven variety and strain tests approved by the Northeastern Forage Crops Technical Committee were planted either in the fall of 1949 (Maryland and West Virginia) or in the spring of 1950 (New Jersey, New York, Pennsylvania, Rhode Island, Vermont). Actually, the New Jersey and Pennsylvania tests were first planted in the fall of 1949, but during the succeeding winter legume seedlings were killed out making it necessary to replant the entire tests in the spring of 1950. Legume stands were drastically reduced in the West Virginia tests during the winter of 1949-50 requiring that legumes be overseeded onto the plots in the spring of 1950.

Only the Maryland and West Virginia plots were cut for yields in 1950, all other tests will not be harvested until the growing season of 1951. As a result, only preliminary data regarding the forage varieties included in the tests can be cited at present. These are supplemented by data from other states obtained in tests considered contributory to Project NE-10:

Red clover - Kenland appears to be adapted generally over the region with Midland usually proving a poor or ordinary performer. Scott, now called Pennscott, appeared promising in Pennsylvania, West Virginia and Maryland - strains designated as "best local" proved well adapted in their states of origin.

Birdsfoot trefoil - Empire and V-102 proved to be more productive than Italian in most tests.

Alfalfa - Narragansett showed superiority in establishment and where cuttings were made was among the highest yielders. Atlantic proved to be of wide adaptation and like Narragansett, appeared less susceptible to leaf diseases and hopperburn. Of the wilt resistant varieties, Ranger and Buffalo, proved among the better adapted in the southernmost states of the region at least. Williamsburg seemed to have promise for Maryland, Delaware and Southeastern Pennsylvania.

Ladino clover - Certified Oregon proved to be the most generally adapted in tests reported.

Bromegrass - Southern types proved themselves best adapted over the region. Of these neither Achenbach, Lincoln, Elsberry or Fischer outyielded one or the other consistently at locations where data were obtained. The southern type bromegrasses also appeared to initiate growth earlier in the spring and generally suffered less from leaf diseases than northern types.

Orchard grass - The Beltsville strain and S-26 proved adapted to southeasternmost areas of the Region and Brage was considered of great promise in New York. Finnish Late Hay and Canadian strains, such as Avon, Oron and Hercules, may be useful in certain areas but more data must be obtained before the areas to which they are adapted are defined.

Timothy - In the few tests reported, commercial timothy outyielded named varieties, although strain differences were few. Of the named varieties probably Hopkins (late), Lorrain (medium) and Milton and Marietta (early) have greatest potentiality.

Seed increases of advanced breeding materials at Cornell (Birdsfoot trefoil and bromegrass), Pennsylvania (orchard grass), Maryland (Ladino clover), Nebraska (alfalfa) and New Jersey (red clover) will make possible the establishment of new tests in 1951 that will speed the development of new varieties of all species of forage crops useful to the Region, making more effective the work of forage crops breeders in the Northeast. Certain of these tests, probably with alfalfa, bromegrass, orchard grass and Birdsfoot trefoil will be initiated in 1951.

By the action of the Technical Committee, Narragansett alfalfa and Lincoln bromegrass were recommended for inclusion in the National Foundation Seed Project. Narragansett was approved by the Planning Committee of the National Project but Lincoln bromegrass was rejected.

A more complete annual report covering activities of Project NE-10 for 1950 has been mimeographed and circulated (dated February 1, 1951).

BROMUS INERMIS BREEDING

Leaders: For the Pennsylvania Agricultural Experiment Station - H. R. Fortmann and H. L. Carnahan
For the Pasture Research Laboratory - J. H. Graham

Clonal evaluation:

a. Data were obtained on the material listed in 1-a and 1-b (p. 6 and 7) of the 1949 report and are being summarized. Marked yield differences between polycross progenies were noted at both cuts. Differences in disease reaction were also apparent. Another year's data will be taken.

Source material:
Another year's data on the spaced-plant nursery of polycross progeny seem desirable before selections are made.

Polycross nursery:
A polycross nursery consisting of 67 clones - (48 Pennsylvania, 13 Maryland. and 6 Minnesota) was established in 15 replications.

Varietal testing:
Table 1. - Average 1950 yields tons dry matter per acre of bromegrass varieties at 5 locations with 4 replications per location. (Seeded alone)

Date Harvested	1st Cut 6/-/50	2nd Cut 8/-/50	Season Total
N. Dak. 404	1.45	.88	2.32
Elsberry	2.05	.93	2.98
Achenbach	2.12	.91	3.03
Nebr. 44	1.92	.79	2.71
Nebr. 36	1.89	.82	2.71
Lincoln	1.93	.89	2.82
Manchar	1.68	.89	2.57
Bromus inermis 12	1.69	.85	2.54
Parkland	1.33	.79	2.12
Fischer	1.96	.81	2.77
Northern Comm'l.	1.60	.74	2.33
Average	1.78	.85	2.63
"F" For Varieties	16.46***	3.82***	14.30***
L.S.D. For Varieties .05	0.39	0.09	0.21
.01	0.51	0.11	0.28
.001	0.65	0.14	0.35

DACTYLIS GLOMERATA BREEDING

Title: Selection, Inbreeding, and Crossing to Obtain Orchard Grass Strains Adapted Particularly for Pastures.

Leaders: For the Maryland Agricultural Experiment Station - T. S. Ronningen and A. W. Burger
For the Pennsylvania Agricultural Experiment Station - H. L. Carnahan and H. R. Fortmann
For the Division of Forage Crops and Diseases - R. A. Wagner
For the Pasture Research Laboratory - A. A. Hanson

At Beltsville, Maryland

Nursery of Spaced Plants: The present nursery consists of 72 selections taken from the old polycross nurseries, plus six additional selections

from a miscellaneous nursery. Three replications of five plants each of these clones were established. This material is being further observed and selected pending results of progeny tests. At the appropriate time certain of these clones will be put together as synthetic strains.

Striking differences were observed during 1950 in rust resistance of the various clones. Rust was more serious on orchard grass this season than it had been for several years, so it provided an excellent opportunity to observe differences in resistance.

Progeny Tests: A progeny test of the plants selected in 1948 from the polycross nurseries was seeded in the spring of 1949. Plots of other strains were also seeded to study their performance and to compare them with the polycross seedings. These include the Beltsville strain, an introduction that has been increased in Arizona, a Kentucky strain, a late maturing strain from Massachusetts, Wisconsin 51, Pasture Laboratory Synthetics Plots 1, 3 and 5, S-37, S-143, two seed sources of Brage, and a commercial source.

These plots were seeded in a split plot design of four replications with maturity groups as the main plots. All were seeded in mixture with Ladino clover. In addition, the early maturing group was seeded alone to compare performance of the material seeded alone and in combination with a legume. Commercial nitrogen is applied to the pure seedings.

Three harvests were made from this test in 1950. Although yields were somewhat variable due to differences in clover and weed content, during this first year, some interesting results were noted. Several of the polycross progenies were more productive than the commercial check. Generally speaking, the selections that were outstanding in pure seedings were also outstanding in mixture with Ladino clover. Beltsville, XXXII-16, and AI-12, were more resistant to rust than other strains or progenies. S-143 exhibited its undesirably clumpy type of growth. It did, however, show considerable resistance to rust. XXXIII-40 was outstanding in early spring growth. S-143, S-37, Arizona, Finnish Late Hay, and Tammisto were all slow to begin growth in the spring.

Further Selection and Increase of the Beltsville Strain: Approximately 35 pounds of seed were harvested from the newly established increase block of the Beltsville strain. The nursery was again rogued of inferior plants.

Tests of the Beltsville Strain: In the spring of 1949 seed of the Beltsville strain was sent to seven states, including Georgia, Missouri, North Carolina, Pennsylvania, Tennessee, Virginia, and Washington. Seed of the 1949 crop was supplied for the Northeast Regional Testing Program. Results from these tests have not yet been reported.

Previous tests of this strain in Virginia were sufficiently promising that they are interested in having it increased for general distribution as soon as possible.

At College Park, Maryland

Clonal evaluation.

Polycross nursery: Further performance data were obtained from the 218 clones established in 1949. Wide differences among clones were noted for most of the characters evaluated. Several clones were superior in vigor, aftermath recovery, and in freedom from foliar diseases. The nursery will be continued through 1951.

Progeny tests: Further observations were made of the plants in the polycross progeny nursery. (1949 Annual Report, page 7). The nursery will be continued through 1951.

At State College, Pennsylvania (Experiment Station)

Clonal evaluation: Data were obtained for the material listed under 1-a and 1-b on pages 7 and 8 of the 1949 report and are being summarized. There were apparent differences in yield at both cuts within all maturity groups.

Source material: Another year's data will be taken on the polycross progeny mentioned under 1-b of the 1949 report before making selections.

Polycross nursery: A polycross nursery of New York and Pennsylvania selected clones will be established in 1951.

Orchard grass introductions: Of thirty-three orchard grass introductions tested as spaced plants only two compared favorably with the checks, namely P.I.173695 and P.I.175131.

Varietal testing:

Table 2. - Average 1950 yields (tons of dry matter per acre) of orchard grass varieties at five locations with 4 replications per location. (Seeded alone)

Variety	1st Cut	2nd Cut	Season Total
Avon	1.81	0.81	2.68
Minn. 2905*	2.00	0.98	2.98
Md. Hay Strain	1.60	1.00	2.56
Thomas (Va.)	1.82	0.99	2.81
Armstrong (Va.)	1.86	1.01	2.87
Oron	1.66	1.04	2.70
S-26	1.31	1.17	2.48
S-37	1.41	1.06	2.47
S-143	1.33	1.04	2.38
Average	1.64	1.01	2.66

*3 locations only

At State College, Pennsylvania (Pasture Research Laboratory)

No new plantings or selections were made in 1950. Seed was harvested from established nurseries, including the seven isolation plots (1949 Annual Report, page 10) and the 106 clones in the 1949 polycross (1948 Annual Report, page 4).

Title: Variation in Carotene and Crude Protein.

Leaders: For the Dominion Exp. Farm, Agassiz, B. C. Canada - M. F. Clark
For the Agronomy Dept., Pennsylvania Agricultural Exp. Sta. - H. R. Albrecht
For the Pasture Research Laboratory - A. A. Hanson

The clones which constitute isolation plots 1, 3, 5 and 7 (1949 Annual Report, page 10) together with top-cross progenies, representing I_0 and I_5 plants crossed onto two testers (1949 Annual Report, page 39) were used to study the variations in carotene and crude protein content in orchard grass. An attempt was made to determine the amount of variation in these two constituents that could be accounted for by (a) stage of sampling and cultural management, (b) inheritance and (c) cutting management.

A significant positive correlation was obtained for carotene and protein when the data for all stages of growth were combined, and when the vegetative sampling dates were considered separately.

Carotene in fresh material and crude protein were significantly higher in aftermath clippings following hay than in comparable cuts simulating pasture. The mean carotene content increased with an increase in the supply of available nitrogen.

The analyses of top-cross progenies suggest that the selection of open-pollinated plants which are characterized by a high carotene content would be effective in increasing the average carotene content.

Carotene determinations on oven dried material were of little value in evaluating clones and treatment effects.

PHALARIS ARUNDINACEA BREEDING

Leaders: For the Pennsylvania Agricultural Experiment Station - H. R. Fortmann and H. L. Carnahan
For the Pasture Research Laboratory - J. H. Graham

Clonal evaluation:

a. Polycross progenies of 46 clones were seeded in 4 replications at State College with a split plot design where the maturity groups were the main plots.

b. Spaced planted rows of the above with 10 progenies and the parent clone included twice were established in 4 replications.

Source material:
The material in 1-b above will also serve as source material.

Polycross nursery:
A polycross nursery of the 46 Pennsylvania clones and 49 New York clones was established in three maturity groups (24 early, 43 medium, and 28 late) with 15 replications.

Varietal testing:
Table 3. - Average 1950 yields (tons dry matter per acre) of varieties of Reed Canary grass. 4 replications at each location. (Seeded alone)

Variety	No. of locations	First Cut	Second Cut	Season Total
Ioreed	1	1.77	0.59	2.71
Superior	2	1.63	0.59	1.85
Aebischer	5	1.38	0.96	2.35
Williams Bros.	2	1.80	1.48	3.27
Average		1.64	0.90	2.54

PHLEUM PRATENSE BREEDING

Title: The Improvement of Timothy by Selection and Breeding

Leaders: For the New Hampshire Agricultural Experiment Station - F. S. Prince, S. J. Higgins and P. T. Blood
For the Pennsylvania Agricultural Experiment Station - H. L. Carnahan and H. R. Fortmann
For the Pasture Research Laboratory - J. H. Graham

At Durham, New Hampshire

Parent material of two strains of timothy was propagated clonally for polycross seed production in 1952.

At State College, Pennsylvania (Experiment Station)

Clonal evaluation:
Polycross progenies of 56 New York clones were established in 10-plant rows with 4 replications.

Source material:
In addition to the material in (1) above, 94 other sources were established in 10-plant rows. These sources included polycross progeny of Purdue selections, all available varieties, and some Pennsylvania farmer sources.

Polycross nursery:
A polycross nursery of the 56 New York clones was established in 3 maturity groups with 10 replications. There were 8 clones in the early group, 33 in the medium, and 15 in the late group.

Varietal testing:
Table 4. - Average 1950 yields (tons dry matter per acre) of timothy varieties at 5 locations with 4 replications per location are given below.

Variety	First Cut	Second Cut	Season Total
Milton	1.71	0.43	2.11
Drummond	1.46	0.36	1.82
Itasca	1.74	0.46	2.20
Medon	1.66	0.36	2.01
S-48	1.34	0.35	1.69
S-51	1.32	0.33	1.64
Average	1.54	0.36	1.91

POA PRATENSIS BREEDING

Title: Breeding and Improvement of Pasture Grasses and Legumes

Leaders: For the West Virginia Agricultural Experiment Station - Collins Veatch

At Morgantown, West Virginia

Seed Production of Selected Strains: Construction of an Aeronautical Laboratory, covering part of the original grass plots, necessitated moving the sod of the two best stripe smut (Ustilago striiformis) resistant strains to a new location; no seed was harvested this year. The seed harvested in 1949 was sown this fall in an area adjacent to the transplanted sod.

LOTUS CORNICULATUS BREEDING

Leaders: For the Pennsylvania Agricultural Experiment Station - H. L. Carnahan and H. R. Fortmann
For the Pasture Research Laboratory - J. H. Graham

Source material:
The material mentioned in 1-a on page 12 of the 1949 report was observed further in 1950. A considerable number of plants died during the winter of 1949-50. This nursery will be maintained.

Polycross nurseries:
a. The polycross nursery established in the fall of 1949 winter killed.
b. The 35 selections from Empire were established in a new polycross nursery with six replications and 3 plants per replication.
c. Seventy-nine selections from several European seed sources were established in a polycross nursery with one plant in each of 15 replications.

Varietal testing:

Table 5. - Average 1950 yields (tons dry matter per acre) of Birdsfoot trefoil varieties at 5 locations with 4 replications per location. (Seeded alone).

Variety	First Cut	Second Cut	Season Total
Bunker	1.22	0.76	1.98
Empire	1.05	0.85	1.90
V-102	1.07	0.70	1.76
CD 504-49	1.05	0.68	1.73
CD-48	1.06	0.70	1.76
By-48	0.91	0.62	1.59
L.G.O.-48	0.88	0.67	1.55
V-101	1.08	0.73	1.80
V-103	0.83	0.55	1.38
Oregon Narrow Leaf	0.84	0.61	1.46
Average	0.99	0.68	1.68

MEDICAGO SATIVA BREEDING

Title: Breeding Improved Alfalfa for the Eastern United States

Leaders: For the New Jersey Agricultural Experiment Station - Warren R. Battle and G. H. Ahlgren
For the Cornell University Agricultural Experiment Station -(See Part III for project leaders and report)
For the Pennsylvania Agricultural Experiment Station - H. R. Albrecht, H. R. Fortmann, and H. L. Carnahan
For the Rhode Island Agricultural Experiment Station- H. M. Tysdal
For the Division of Forage Crops and Diseases - O. S. Aamodt
For the Pasture Research Laboratory - A. A. Hanson and J. H. Graham

At New Brunswick, New Jersey

Progenies of 149 wilt resistant selections of Atlantic parental strains were seeded in replicated broadcast plantings in the fall of 1950. Notes will be taken on establishment and early vigor. The best progenies will be inoculated with wilt and transplanted to a spaced nursery in the summer of 1951, for further evaluation and selection.

About 10,000 plants of the Atlantic parental strains were inoculated with wilt and established in a spaced nursery in the Spring of 1950. Forty-eight percent of the plants survived through the first season, but many of these will probably die this winter. The best of the survivors will be selected next year for further evaluation.

Seventy-five new plant introductions of alfalfa, principally from Asia and Africa, were seeded in the spring of 1950 for preliminary observation and evaluation. Seedings were replicated twice in six foot rows. Notes were taken on vigor, insect reaction, and general plant characters. More comprehensive data will be obtained when the plants are fully developed.

Several hundred spaced plants of Rhizoma were observed for spreading habit at the end of the second year of growth. Very little tendency to spread has been evidenced so far.

Two years' yield data (a total of 4 harvests) have been summarized for the study of seedling vigor as an indicator of nature yielding ability. Initially, the 10% of a plant population which showed the greatest seedling vigor was selected, and has been compared with an equal number of plants drawn at random from the remaining 90% of the population. The selected plants have outyielded the checks by an average of about 20% dry weight.

Three years' data from the 1948 Advanced Uniform Nursery of 21 strains and varieties indicate that Atlantic and Narragansett are the outstanding varieties in the test. All entries have maintained good stands with the exception of Ladak.

At State College, Pennsylvania (Experiment Station)

Data have been obtained on the nurseries listed on p. 17 of the 1949 report and have been forwarded for inclusion in the annual report of the Alfalfa Improvement Conference.

One additional observation nursery consisting of 49 entries was seeded with 6 replications in rows 9' long. A 7 x 7 triple lattice design was used.

At State College, Pennsylvania (Pasture Research Laboratory)

Twenty-eight new selections were made in the replicated clonal planting of 225 clones which had been subjected to two management treatments (1949 Annual Report, page 19). These plants will be multiplied for further clonal evaluation and grown in Nebraska to obtain observational data on seed production.

A number of the F_2 progenies responded much better in 1950 than in the previous year. A rather wide range in spreading habit was encountered within certain progenies. Fifty-one plants representing various degrees of the rhizomatous habit were selected for clonal evaluation. Six spreading and six erect types were selected for the production of polycross seed in two restricted polycrosses in order to compare the persistency and productivity of their progenies.

At Kingston, Rhode Island

During the 1950 season data were obtained from two advanced and three polycross nurseries. One additional nursery of each type was established during the year.

Seed from outstanding plants in the polycross nurseries will be used to establish another nursery in 1951. Narragansett alfalfa and four related polycross selections are being tested for bacterial wilt resistance in the greenhouse. Resistant material will be included in the 1951 polycross nursery.

Three cuttings were made of the advanced nursery established in 1948. The highest yields, obtained from Atlantic, Narragansett, 77C213, and 77C229, were all over 5 tons per acre on a 15% moisture basis. One complete cutting was taken from an advanced nursery started in 1949. A224-1, Narragansett and Atlantic were the leading strains in this nursery.

The growing season of 1950 was favorable for alfalfa. The rainfall for the season was below normal but there were no prolonged periods of dry weather. A good seed harvest was obtained from the Narragansett seed increase areas this year.

TRIFOLIUM PRATENSE BREEDING

Title: The Improvement of Red Clover by Selection and Breeding

Leaders: For the New Hampshire Agricultural Experiment Station - L. J. Higgins, F. S. Prince and P. T. Blood
For the Pennsylvania Agricultural Experiment Station - H. L. Carnahan and H. R. Fortmann and R. G. Hanson
For the Pasture Research Laboratory - J. H. Graham

At Durham, New Hampshire

Selections were made during the year with respect to mildew resistance. Intercrossing among the remaining families was continued. Yields were secured during the season on the eight strains of red clover seeded in 1948. Listed in descending order, the relative yields of these strains for the two years were as follows: Dollard, 100; Cumberland, 97; Ottawa, 96; Purple Seeded, 95; N. H. Red, 90; Kenland, 87; Midland, 75; Wisconsin Mildew Resistant, 73.

At State College, Pennsylvania (Experiment Station)

Source material:
The source material described on p. 19 of the 1949 report was observed in 1950. Approximately 80% of the plants were killed by May 15 due to *Sclerotinia*. The remaining plants were clipped at the bloom stage and the majority of these plants failed to recover as a result of root borer infection and *Fusarium*.

In mid-August the less desirable surviving plants were removed leaving 101 plants of the original 8884 plants. Open pollinated seed was harvested from these plants and an attempt was made to duplicate them. Many plants were infected with *Fusarium* or virus and it is questionable whether enough clonal material will be available in the spring to establish a polycross nursery.

The open pollinated seed will be used to establish a second cycle source nursery in 1951.

Fusarium test:
Remnant seed of the material used to establish the 1949 source nursery was used to obtain 1600 plants for a greenhouse Fusarium test. Forty-seven plants survived this test. However, all of these plants except 3 died when the temperature of the greenhouse was raised to 80°F. this fall.

Varietal testing:
a. Six replications of 12 varieties and strains were seeded in broadcast plots at State College in 1950. Two replications were inoculated with Sclerotinia this fall. These two replications and two additional replications will be sprayed to control the root borer in the spring and two replications will be left untreated. It is hoped that some information will be obtained as to the relative importance of the various factors which cause stand losses and whether all varieties react similarly under the various treatments.
b. Results of varietal tests in 1950:
Varietal Testing:
Table 6. - Average 1950 yields (tons dry matter per acre) of red clover varieties at 5 locations with 4 replications per location. (Seeded alone).

Variety		First Cut	Second Cut	Season Total
Pennscott		1.48	1.15	2.63
Kenland		1.20	0.92	2.12
Cumberland		1.07	0.73	1.80
Midland		0.92	0.59	1.51
Craig Mammoth		1.31	0.40	1.71
Wis. Mildow Resistant		0.98	0.56	1.53
Med. Commercial		0.80	0.50	1.30
Mammoth Comm'l		0.92	0.32	1.23
Average		1.08	0.64	1.73
"F" for varieties		18.86***	37.06***	43.75***
L.S.D.	.05	0.15	0.13	0.14
	.01	0.20	0.17	0.18
	.001	0.25	0.21	0.23

At State College, Pennsylvania (Pasture Research Laboratory)

Resistance of Red Clover to Sclerotinia trifoliorum
From observations during the screening of more than one hundred strains of red clover for possible resistance to Sclerotinia crown rot (1949 Annual Report, page 22) 36 strains were selected for further tests under greenhouse and field conditions.

In a field test the strains were seeded in the spring of 1950 in 3'x8' plots, replicated four times. After stand counts were made in the fall, the plots were inoculated in November by spreading a small amount (approximately 5 cc/sq.ft.) of the dried grain over one-half of each plot. Population counts will be made again in the spring. The results obtained will be compared with those in the greenhouse.

In greenhouse tests the strains were grown in flats in 12-plant plots replicated 5 times in each test. Plants were inoculated when they were about 2 or 3 months old when 3 or 4 shoots had developed. Infection was accomplished in the usual manner by placing grain inoculum around the crown of the plant and incubating the inoculated plants in a greenhouse bench moist chamber at 15°C. Results from two such tests indicate that Kenland (U.S.) Altaswede (Canada) and several of the Swedish strains were the most resistant of the strains tested. Further tests will be made this spring.

The polycrossed progenies of nine plants which had survived two greenhouse inoculations were tested in the spring of 1950. Progenies of two of the clones had significantly more survivors than those of the other seven clones and the Kenland strain which was used as a check. Survivors of the test were divided into several groups, polycrossed, and their progenies were tested this winter. Progenies having the two more resistant clones in their parentage again had a larger percentage of survivors than those derived from the other clones. Single crosses were made in all possible combinations between these two clones plus clones which had survived 3 or more inoculations. These progenies are being tested in the greenhouse this winter. In addition the single crossed progenies from six of the clones were set out in the field as spaced plants last fall and inoculated in an attempt to determine their resistance to the disease under field conditions.

Field Inoculations.

Further tests of the pathogenicity of Sclerotinia trifoliorum under field conditions (1949 Annual Report, page 47) are being conducted on red clover. In addition to the field inoculation of red clover strains and of single cross progenies of resistant clones, an experiment was set up in the fall of 1950 to determine the amount of inoculum necessary to obtain differential killing and the effect of mulching at different rates of application. Observations of inoculation of a 3 foot strip across a red clover variety trial suggests that artificial inoculation of the plants in the field may offer an entirely new and easier approach to the problem of obtaining resistance to Sclerotinia crown rot.

Resistance of Red Clover to Fusarium sp.

Approximately 90 strains of red clover have been screened for possible resistance to Fusarium. Infection was obtained by placing the plants in Fusarium infested soil in a greenhouse bench (1949 Annual Report, page 21). Significant differences were obtained between red clover strains in their ability to withstand attack by the organism under those conditions. The Pennsylvania Scott strain of red clover was more resistant than other common varieties of the region. Some of the midwestern strains also have shown promise as possible sources of resistance to the disease.

At the completion of each test survivors were examined and rated as to degree of infection. The polycrossed progenies of the healthy survivors are being tested this winter. Results from one test indicate that resistance to the disease under the conditions

studied is inherited. Further information will be obtained when the remaining polycross progenies are tested.

Artificial inoculation with grain.

In order to obtain a further evaluation of grain inoculum as a method of artificial inoculation of red clover with Fusarium (1949 Annual Report, page 21) an experiment was conducted using the following treatments: sterilized grain, autoclaved composite inoculum, the composite inoculum (used in artificial inoculations) and no grain.

Plants growing in flats were dug up, scarified and placed in 4" pots of soil to which a uniform amount of the grain had been added. The pots were set in the bench used for Fusarium inoculations and held at the optimum temperature for the organism. As shown in Table 7 the most severe infection was obtained with the composite grain inoculum. The comparatively large amount of injury obtained with the sterilized composite inoculum suggests that some toxic substance produced by the fungus may be an important factor in the killing of red clover. Further investigations are planned.

Table 7. Effect of various treatments on the survival of red clover seedlings artificially inoculated with Fusarium sp.

Treatment	Tested	Number of Plants Dead	Injured	Healthy
Sterilized grain	54	0	19	35
Sterilized composite grain inoculum	53	2	41	9
Composite grain inoculum	54	17	36	1
Check	54	1	7	46

Culture studies.

One hundred isolates of Fusarium were obtained from tap roots of red clover collected from fifty-three different locations in the Northeast. All cultures were classified on PDA and Tochinai media with respect to pigmentation and mycelial growth. On this basis 19 cultures were chosen as representatives of morphological types and their pathogenicity to red clover was determined using the dried grain technique. Results showed that there was no correlation between morphological type and pathogenicity. Significant difference in pathogenicity of the cultures was obtained.

TRIFOLIUM REPENS BREEDING

Title: The Improvement of Ladino clover by Selection and Breeding

Leaders: For the New Hampshire Agricultural Experiment Station - F. S. Prince, L. J. Higgins and P. T. Blood
For the New Jersey Agricultural Experiment Station - G. H. Ahlgren
For the Pennsylvania Agricultural Experiment Station - H. R. Albrecht, W. E. Knight
For the Pasture Research Laboratory - A. A. Hanson

At Durham, New Hampshire

Further intercrossing among promising families was continued during the year. Final selections will be made in the spring of 1951 of the families to be included in a strain. These will be tested and evaluated in 1951 and 1952 in comparison with Ladino clover developed under similar programs.

At New Brunswick, New Jersey

Progeny Tests of Diallel Crossing System.
Seed Production: Seed production was continued during 1950 with the three crosses 6-5 x 6-16, 6-10 x 6-13, and 6-9 x 6-12, as well as on the close-pollinated clover plots. Sufficient seed is available for fairly extensive testing of the 6-10 x 6-13 cross, and more limited testing of the others.

Field Plot Tests: Two tests of the above materials have been established. The first includes 6-10 x 6-13, 6-5 x 6-16 and a close-pollinated line, in comparison with Ladino clover strains from Oregon, Idaho, Montana, California, and Italy. This seeding is in its first year and only general data have been obtained.

The second planting is a more extensive test of 6-10 x 6-13 in comparison with 18 other strains from the United States and Europe. Based on two years' data, it appears that the cross compares very favorably with the best of the other strains in yield and winter survival, and is superior in leaf hopper resistance. It possesses a dense type of growth, and is somewhat shorter than the other Ladino clovers.

At State College, Pennsylvania (Pasture Research Laboratory)

Forty individual plants were selected from superior progenies in the 1948 progeny test (1949 Annual Report, page 23). Selections were based on the following observations: fall vigor 1948, spring vigor 1949, recovery after clipping, fall vigor and spring vigor 1950. These clones were used to establish a polycross nursery with eight replications of five plants each, in the spring of 1950.

A major portion of the 1948 polycross which was re-established in the spring of 1949 was lost during the winter of 1949-50. Polycross seed was not collected in 1950, but 23 clones were selected for persistency and spring vigor.

Notes were taken on 1300 spaced plants grown from Breeder's Ladino clover seed. This material appears to be quite uniform and practically free of off-types. Observations were made on a limited number of octoploid progenies obtained from Vermont.

Field results from single cross progenies indicate that in general good x good crosses are superior to poor x poor crosses in their ability to survive the winter and produce satisfactory spring growth (1949 Annual Report, page 24). Wide differences in yield and winter survival appeared between polycross progenies tested at State College. The differences were less apparent in a similar

test conducted at Harvey's Lake. Breeder's Ladino clover was one of the highest yielding sources in these two tests.

A large number of characters was studied in the greenhouse in the winter of 1949-50. The total number of stolons, lateness of flowering and vigor following flowering were significantly and positively correlated with good winter survival. Rooting, Sclerotinia reaction and day-length response of the parental and selected F_1 clones are under study in additional greenhouse experiments.

NUTRITION STUDIES

Title: The chemical composition of the pasture grasses

Leaders: For the New Hampshire Experiment Station - T. G. Phillips
For the Pasture Research Laboratory - J. T. Sullivan

Studies have been continued on grasses growing in small plots at State College, Pennsylvania. Chemical analyses are being made partly at the New Hampshire Station and partly at the Pasture Research Laboratory (1949 Annual Report, page 25).

Further analyses were made on the samples gathered in 1949, namely for fructosan, sugars, crude fiber, ether extract and nitrogen-free extract. The percentages of fructosan were higher in the more mature plants in all species in which it was present. It was absent at all times from bromegrass (tops only) and did not appear in tall oatgrass until the dough stage nor in Alta fescue until the bloom stage. Sugars were variable, as was found in the preceding year, and the causes of these variations require further study. Nitrogen-free extract increased and ether extract decreased with plant maturity.

These complete the chemical analyses of samples gathered during the seasons of 1948 and 1949, two years in which samples were taken only during the spring and at different stages of plant maturity. The results are being studied with the object of determining differences between species, agreement between the two years, correlations between constituents and the effect of maturity on chemical composition.

Early maturing species differed in composition from late species. For example, when compared at the same stage of growth, Reed Canary grass and Kentucky bluegrass were higher in protein and lower in lignin than timothy and red top but when compared at any one calendar date the reverse was usually true. An early clone and a late clone of orchard grass differed from each other in the same manner. This suggests that early maturing species and strains have higher nutritive values than late ones of a like degree of maturity and should be preferred as hay plants if harvesting conditions are suitable.

In 1950 samples were gathered throughout the growing season; each plot was cut when the grass reached grazing height. The numbers of successive cuttings were as follows:

Alta fescue	8
Orchard grass	7
Kentucky bluegrass	6
Tall oatgrass	5

Reed Canary grass	5
Bromegrass	4
Timothy	4
Red top	3

Because of the invasion of other species in the plots during the later part of the season, a late cutting of tall oatgrass was omitted and some of the replications in other species were likewise not sampled. Analyses of these samples are being made. A new series of plots was sown in the late summer of 1950 and will be used for future studies.

Title: Measurement of the Nutritive Value of Pastures and of Pasture Plants

Leaders: For the Pennsylvania Agricultural Experiment Station - R. W. Swift et al, and J. B. Washko
For the Pasture Research Laboratory - J. T. Sullivan and V. G. Sprague

Following up the work summarized in last year's report, an experimental program is now under way which involves the further nutritive evaluation of specific forages as determined by digestion and calorimetric experiments with sheep. Because the duplicate determinations of the metabolizable energy of Kentucky bluegrass were not closely concordant in the 1949 work, this datum is being determined again.

During 1950 orchard grass, bromegrass, Kentucky bluegrass, timothy and Ladino clover were harvested at various stages of growth for feeding trials. The first cuttings of the grasses were made when the heads had just emerged from the boot but before they had expanded. Five additional cuttings of orchard grass were made at various heights of the leaf stage. One additional cutting of the bromegrass was made, with the majority of the plants at the leaf stage but a few culms were showing panicles. Two additional harvests of timothy were made , one at the beginning bloom and one at full bloom. Since the Ladino clover plots at State College were badly contaminated with weeds a Ladino clover harvest was made from a yield trial at Harvey's Lake, Pennsylvania. Accordingly a third cutting of Ladino clover was harvested when only a few blossoms were showing in early September at this location.

The grass plots from which the harvests were made were fertilized with 560 pounds of a 5-15-15 fertilizer in October, 1949. In early April they received 50 pounds of nitrogen per acre in the form of ammonium sulfate. An additional 40 pounds per acre of nitrogen in the form of ammonium sulfate was applied in June on the orchard grass after the third harvest. The other grass species received no additional fertilization than that already indicated. The Ladino clover had been fertilized with 300 pounds per acre of 0-20-20 in midsummer after removal of the second cutting.

PASTURE MANAGEMENT EXPERIMENTS

Title: Evaluation of grasses and legumes for hay, silage and pasture

Leaders: For the Pennsylvania State College - P. H. Margolf, M. G. McCartney, J. B. Washko, R. P. Pennington and A. L. Haskins
For the Pasture Research Laboratory - V. G. Sprague

Experiment I: Evaluation of an orchard grass-Ladino clover association for turkey pastures under two systems of grazing management, differing in intensity.

Pasturing of these two areas began June 5 for the sixth successive year. The populations of the areas were 150 and 300 poults, respectively, as in the preceding years. Both areas were grazed rotationally, about three weeks being required for a rotation. All equipment, shelters, feeders and waterers were moved daily. The poults were fed in outdoor hoppers a 20 percent protein turkey growing mash mixture, whole oats, whole wheat, whole corn, oyster shell and grit.

The turkeys were 13 weeks of age when placed on these areas and were removed when 32 weeks old. Table 8 shows the 1949 results obtained from the two areas.

Table 8. Gain in weight of turkeys and carrying capacity of 6-year old orchard grass

Grazing Intensity	Number of Birds per Acre at beginning of season	Number of Birds per Acre at end of season	percent mortality	Gain in Body Weight lbs./A.	Pounds of Feed Required to Produce One Pound of Gain
High	150	144	4	1883	5.86
Low	75	72	4	941	5.97

Normal growth was obtained from both groups. The average body weights in pounds per bird were 12.8 and 13.0 for the hens and 23.5 and 23.6 for the toms in the low and high intensity grazed areas, respectively. A mortality of 4 percent is considered very low for grazing these areas for six consecutive years. It is the plan to use these areas again in 1951 as long as adequate ground coverage with the orchard grass and a reasonably low mortality of the poults can be maintained.

Experiment III: Carrying capacity of individual species of grass and legume for turkeys on pasture.

Grazing trials with turkey poults were continued in 1950 on the one-acre ranges with the following species seeded alone: Ladino clover, smooth bromegrass, orchard grass, Reed Canary grass and Kentucky bluegrass. Each range was sampled periodically to determine the amount of standing forage available for turkey grazing and for chemical analysis. The total amount of forage available expressed in terms of dry matter

per acre for the season for each species is as follows: orchard grass 2643 pounds, Kentucky bluegrass 2593 pounds, Reed canary grass 2184 pounds, bromegrass 2031 pounds and Ladino clover up to August 10 was 1242 pounds. The orchard grass and Kentucky bluegrass carried 125 turkeys per acre for the full season from the first week in May to the first week in October and looked superior to other species in carrying capacity. The smooth bromegrass carried the full number of birds until the first week in September when the number had to be reduced to 90 percent because of insufficient forage.

Since the facilities were not available to put poults on all replications of all species on the same date it was thought advisable to obtain, during 1950, preliminary information on the feasibility of reducing the amounts, or even eliminating completely, the more expensive concentrates in the previously used turkey growing mash and those which high quality forage could be expected to supply. Until all ranges were available on June 27, all birds received a 20% protein turkey growing mash mixture, whole corn, whole wheat, whole oats, oyster shell and grit.

On the above date three rations: 1, 2, and 3 were fed to the poults on Replications I, II and III respectively. Ration 1 was a 20% protein turkey growing mash mixture that included animal and vegetable proteins and vitamin supplements. Ration 2 was made up to 15% protein with meat scrap as the only source of animal protein, but no vitamins were added. Ration 3 had a protein analysis of only 11% made up entirely from plant sources and no added vitamins. Calcium and phosphorous were maintained at 2.7% and 1.4% respectively in all rations. In addition to the mash mixtures fed each group, the turkeys had access to whole corn, wheat, and oats fed separately in hoppers. While slightly greater body weight gains per acre (Table 9) were made by those birds receiving a complete ration including animal protein and vitamin supplements, the cost of producing one pound of gain was lower where the forage supplied these more expensive components of the diet.

Table 9. Body weight gains of turkeys grown on pasture supplied with three supplemental rations

	Ration 1	Ration 2	Ration 3
	pounds	pounds	pounds
Feed required to produce one pound of gain	7.0	7.0	8.2
	Cents	Cents	Cents
Cost to produce one pound of gain	24.8	23.9	23.1

Systems of Grazing Management on Orchard Grass-Ladino Clover. The five-year grazing management study of orchard grass-Ladino clover was terminated in the fall of 1949 (1949 Annual Report, page 28). Before this field site was used for another experiment, several

fertilization treatments were applied to provide additional information on production of dry matter and establishment of Ladino clover in a grazed orchard grass sward from which the Ladino clover had disappeared during the winter of 1949-50. Two applications of potash at 50 pounds per acre of K and three applications of ammonium nitrate at 40 pounds per acre of N were applied to each plot on strips, 8 feet wide and extending the length of the paddock. In addition 8 tons per acre of manure were applied to those plots previously having deferred grazing and on which the Ladino clover had been disappearing since 1946. The average dry matter yields from the fertilized strips on all plots showed a 59% increase in aftermath yield due to 120 pounds of N applied. The response from manure was only slight and almost no response to potassium was evident. Ladino clover did not reestablish itself under any of the fertility and grazing management treatments used.

Title: Physiological factors and cold-resistance of Ladino clover

Leaders: For the Pennsylvania Agricultural Experiment Station - T. R. Flanagan
For the Pasture Research Laboratory - V. G. Sprague

Ladino clover, one of the important forage legumes in the Northeast is often killed during the winter period. This loss may be caused by a number of factors, one of which is the susceptibility of this plant to low temperatures. The development of techniques for measuring the cold resistance of this species and determining the factors affecting cold resistance was initiated in the winter of 1949-50.

The electrical conductivity method used successfully with alfalfa and wheat was shown to be adaptable for use with Ladino clover stolons. Measurements of the relatively hardy Ladino clover indicated that in late September the plants were killed by temperatures of -10°C., in late October the plants were injured, but not completely killed, and in late November and December the plants were not seriously injured by these low temperatures. Greenhouse recovery of frozen stolons paralleled the results obtained by the electrical conductivity method used.

In a cold hardiness test of 8 clones conducted in 1949 and 1950 certain clones were consistently susceptible to low temperature injury whereas others were consistently resistant.

Title: Effect of height and frequency of cutting on the carbohydrate reserves of Ladino clover

Leaders: For the Maine Agricultural Experiment Station - C. H. Moran
For the Pasture Research Laboratory - V. G. Sprague

The carbohydrate content of a forage plant is believed to be an important factor in the productivity and persistence under defoliation treatments. This has been demonstrated with alfalfa, but with Ladino clover only limited information of this type is available. To investigate the changes which take place in the stolons and roots of

Ladino clover when subjected to defoliation, and to determine which carbohydrates may serve as reserves, a series of plants was grown and subjected to several clipping and recovery treatments. Preliminary analyses of stolons of various morphological plants of Ladino clover were made on field-grown material to determine which portions of the stolon should be analyzed. The parts of the stolons, analyzed for glucose, fructose, sucrose, and starch, included: (a) first five internodes, (b) second five internodes, and (c) next 5 to 7 internodes. Results from an October 17 sampling, while the plants were still actively growing, indicated that there were appreciably higher percentages of sucrose and starch in the older portion of the stolon (second five internodes and next 5 to 7 internodes) than in the five internodes nearest to the growing tip. On November 21 when growth had almost stopped, the first 5 internodes were somewhat higher in sucrose than the older stolon tissue, and were almost the same in starch content. From these preliminary results it was decided to use the first 10 internodes of the stolon as the sample for indicating the carbohydrate storage conditions of the plant.

Incomplete analyses of stolons and roots from Ladino clover clones and seedlings grown in the greenhouse indicate that starch, sucrose, and reducing sugars function as reserves in that order of importance, and that the stolons contain higher percentages of these substances than the roots.

PASTURE RENOVATION EXPERIMENTS

Title: Grassland renovation trials in Connecticut

Leaders: For Storrs Agricultural Experiment Station - B. A. Brown and R. I. Munsell
For the Pasture Research Laboratory - V. G. Sprague

At Storrs, Connecticut

Results: Very little Ladino clover has been established on either disked or herbicide treated two-acre plots in the long-time grazing experiment. On the disked plot, this failure cannot be due to recovery and competition of the grasses because there was no Ladino on bare areas, either. These failures are puzzling since the soil had been quite liberally fertilized and seeding had been done at three different times from very early spring to late summer. In an effort to find explanations for the poor results, soil from an adjacent, untilled plot has been collected by three two-inch layers, fertilized in various ways, placed in pots in the greenhouse and seeded to Ladino clover. No results are available now.

The effects of growing millet and rye before seeding Ladino clover on another disked, two-acre pasture are being studied. It is thought that the mellowing and smothering effects of the annual crops may improve conditions for the Ladino clover. In August and September 1950, only 500 pounds of digestible nutrients

(about thirty cow days) were obtained from well fertilized Japanese millet seeded early in July.

Two long untilled plots treated with Atlacide at 100 pounds December 8, 1943 and seeded to Ladino clover in the early spring of 1944, had 60 percent Ladino clover stands in September 1950. The management has been one mid-June mowing and two or three subsequent grazings each year.

Title: Date of seeding legumes, grasses and weeds

Leaders: For Vermont Agricultural Experiment Station - A. R. Midgley, and K. B. Varney
For the Pasture Research Laboratory - V. G. Sprague

At Burlington, Vermont

Seedings of all the major legumes, grasses and weeds were again made on four dates (December, March, April, May). A heavy rainstorm just after the surface soil thawed, caused considerable washing and in some cases a mixing together of certain seeds. Because of this trouble it was impossible to make proper comparisons of early and late seedings. The trouble has been corrected with adequate drainage ditches and suitable sod strips. Information which could be salvaged, however, was similar to the previous year. In general, most grasses did well with a very early spring or even winter seeding, while many legumes seeded at the same time showed a high mortality. Regardless of time of seeding, better stands resulted from seed covered with some soil than from seed uncovered, probably because of protection from extreme climatic variations. Soil temperature recordings show that even a small soil covering, levels out the surface extremes in temperature.

MAINTENANCE OF LEGUMES

Cooperative investigations of the Division of Soil Management and Irrigation, the Pasture Research Laboratory, and Agricultural Experiment Stations and Extension Services of Cornell (New York), Maryland, New Jersey, New Hampshire, Pennsylvania and Storrs (Connecticut).

Title: The relation of soil properties to persistence of perennial legumes

The objective of this investigation was to determine, through survey methods, the importance of various soil factors affecting persistence of perennial legumes. Areas were selected to afford comparisons between good stands of perennial legumes that had persisted for several years and fields where legumes had not persisted satisfactorily. Although both alfalfa and Ladino clover were included in the study, most of the work was with alfalfa. Fields in which failure of alfalfa obviously resulted from poor drainage were avoided. In fact most of the fields selected were on limestone soils where alfalfa was considered to be well adapted. Data were obtained regarding fertilization, cropping history, and crop management practices. Field appraisals included soil type, profile examination, slope, botanical estimates, root development, symptoms of nutrient deficiencies, and incidence of diseases. Soil

samples were taken at depths of 0 to 3 and 3 to 6 inches and thereafter by horizons usually to a depth of about 18 inches. A total of 114 sites was sampled in New York, 7 in Maryland, 10 in New Jersey, 11 in New Hampshire, 16 in Pennsylvania and 3 in Connecticut.

The soil samples were analyzed for pH, available phosphate, organic matter, total exchange capacity, exchangeable calcium, magnesium, potassium, and manganese, and release of non-exchangeable potash in boiling nitric acid. In a number of locations cores of both surface soil and subsoil were taken with a Lutz sampler and volume weight, pore size distribution, and the moisture curve determined.

The samples taken at the 0 to 3 inch depth were analyzed by the procedure recommended in U.S.D.A. Circular 757. On the samples from the other depths these same procedures were used for pH value and available phosphorous. Calcium, magnesium, and potassium in the samples taken at 3 to 6 inches and deeper were determined in Morgan's extracting solution essentially as outlined by Peech and English (Soil Sci. 57: 167-195. 1944) except that the readings were made on a spectrophotometer. Determinations were made of the non-exchangeable potassium released by boiling for 10 minutes in 1N nitric acid as proposed by DeTurk, Wood, and Bray (Soil Sci. 55: 1-12. 1943).

The results of the laboratory tests show a wide range in all of the factors evaluated. The relation between soil tests and persistence of legumes, however, was poor.

A re-examination of many of the fields was made one or more times during the year following sampling. In a number of cases three to six year old stands of alfalfa that originally were rated very good were rated fair or even poor a year later. In such cases the plants were being killed by bacterial wilt and possibly other disease organisms. Bacterial wilt was found throughout the entire area surveyed, but the incidence of the disease was greater in areas where alfalfa has been grown extensively. This may partly explain the fact that some of the oldest stands of alfalfa were found in areas where alfalfa is not a major crop.

The incidence of bacterial wilt appears to be a serious complicating factor in any survey approach to the problem of soil factors affecting persistence of alfalfa. Bacterial wilt, for example, may largely kill a good stand of alfalfa within one year. Obviously, therefore, any classification of the soil based on persistence of alfalfa may be misleading.

The value of lime and fertilizer for the growth of alfalfa are well recognized, but regardless of lime or fertilization, it appears that good stands of wilt susceptible varieties usually cannot be maintained beyond three or four years particularly in areas where alfalfa has been grown extensively. Future studies of soil factors affecting persistence of alfalfa should be made with wilt resistant varieties.

RUNOFF FROM PERMANENT PASTURES IN PENNSYLVANIA

Leaders: For the Pennsylvania Agricultural Experiment Station - R. B. Alderfer
For the Pasture Research Laboratory and Division of Soil Management and Irrigation - R. R. Robinson

Results of earlier investigations indicate that serious runoff losses from permanent pastures may occur during storms of high rainfall intensity (1949 Annual Report, pages 34, 35).

Field plots were established on Hagerstown silty clay loam in the spring of 1950 to evaluate the effectiveness of various treatments in decreasing runoff in an old Kentucky bluegrass pasture. At the time the experiment was started, infiltration capacity was relatively high (very little runoff from the plots receiving simulated rainfall at the rate of 1-1/2 inches per hour). Therefore the experimental area was compacted with a heavy roller early in the spring. Following this treatment runoff losses averaged about 50% during a 60 minute period of simulated rainfall at the rate of 1-1/2 inches per hour. Thus infiltration capacity following artificial compaction was comparable to that on a number of pastures investigated during the survey conducted the previous year.

Plot treatments involved topdressing with superphosphate, muriate of potash, and gypsum, disking with a heavily weighted disk, cultivation with an aerifier, and cultivation with a field cultivator from which part of the shovels were removed and the remaining ones cut to about one inch in width. The shovels, which were 18 inches apart, penetrated to a depth of 6 to 8 inches with relatively little injury to the sod.

Runoff losses during the period of simulated rainfall were not appreciably affected by topdressing treatments, disking, or aerifying. The disk and the aerifier penetrated to a maximum depth of 3 or 4 inches and apparently this was not deep enough to permit water to pass readily through the compacted zone.

The cultivation treatment gave complete control of runoff on the plots protected from grazing. Under grazing, however, the cattle tended to congregate on the cultivated areas and the resulting compaction decreased the effectiveness of this treatment. This treatment, however, appears to merit further study.

Grazing management was an important factor affecting runoff. Plots that were protected from grazing following compaction showed marked improvement during the season. On other plots in the same pasture that were not artificially compacted, but were open to grazing, runoff during the 60 minute trial averaged only 3% in May, but increased to 30 percent during midsummer and fall.

SOIL FERTILITY AND SOIL MOISTURE IN GRASSLANDS (WITH DELAWARE, MAINE, NEW JERSEY AND RHODE ISLAND)

Leaders: For the Delaware Agricultural Experiment Station - Leo J. Cotnoir, Jr.
For the Maine Agricultural Experiment Station - C. H. Moran, W. C. Libby, Stanley Junkins (J. S. Hardesty and S. Von Day, Soil Conservation Service)
For the New Jersey Agricultural Experiment Station - E. R. Purvis, W. A. Mitcheltree (G. A. Quackenbush, Soil Conservation Service)
For the Rhode Island Agricultural Experiment Station - Donald A. Schallock, H. C. Albritten, Irene H. Stuckey and Milton Salomon
For the Division of Soil Management and Irrigation and the Pasture Research Laboratory - R. R. Robinson

A survey of soil fertility levels was made on dairy farms from certain counties in Maine, Rhode Island, New Jersey, and Delaware (1949 Annual Report, pages 36-38). From 12 to 19 farms were selected at random from each area, and soil samples taken from most of the fields on each farm. Surface soils of grasslands were sampled at depths of 0 to 3 and 3 to 6 inches, whereas in cropland samples were taken of the 0 to 6 inch layer. Subsoils were sampled to a depth of 12 inches. The soils were analyzed by the Peech and English modification of Morgan's method for calcium, phosphorous, potassium and magnesium. Organic matter and pH value were also determined. The soil moisture studies have not been completed.

Since the results of the soil tests probably will be made available in mimeographed form, only a brief summary will be reported here.

In general the soil tests show surprisingly little difference between croplands, permanent pastures, and meadows. Grasslands, particularly permanent pastures, averaged higher in organic matter in the 0 to 3 inch layer than croplands, but not in the 3 to 6 inch layer. Available potassium in permanent pastures averaged about 30 percent higher than in meadows. In both pastures and meadows the potassium level in the 0 to 3 inch soil layer was about twice as high as at 3 to 6 inches. The potassium level in cropland is approximately the same as in the 0 to 3 inch layer in grasslands (average for pastures and meadows).

The soil tests indicated a wide range in soil fertility levels. Organic matter content was highest in Maine, with most of the soils testing between 4 and 8%, whereas the soils from Delaware averaged 2.1%. Except in the samples from New Jersey, where most of the soils tested above pH 6.0, the pH values ranged from high to low. Merrimac soils in Rhode Island were the only ones that were generally high in available phosphorous. The lowest tests for phosphorous were obtained in New Jersey on the Annandale soils, which averaged only 1.5 pounds per acre as compared with an average value of 26 pounds on the Merrimac soils. Potassium levels were consistently high only in the soils from Delaware. In all other states potassium levels ranged from low to high.

Available phosphorous and pH values were higher in pastures and meadows that were rated good than in those rated poor. No relation was found between the potassium tests and the rating of grasslands.

Field trials together with further laboratory studies are planned to determine the response to phosphorous and potassium on soils of varying fertility levels as indicated by soil tests.

PART II

RESEARCH AT THE LABORATORY

CYTOGENETICS AND BREEDING

Varietal Improvement in Dactylis glomerata and Trifolium repens

Inbreeding in Orchard grass: Yields were taken in 1950 from the randomized block experiment planted with polycross seed from 52 I_4 lines and 19 parental clones (1948 Annual Report, page 26; 1949 Annual Report, page 39). On the basis of the 1949 results only one management treatment was used in 1950. This involved a silage cut removed at the early boot stage and subsequent clipping to simulate rotational grazing.

In 1949 the differences between families were not significant, either for the individual cuts or for the total seasonal yield. In 1950 the difference between families was significant for the first and second cuts, but no significance was demonstrated for the third and fourth cuts or for the total seasonal yield. In addition, the trends observed within the 19 families in 1949 were not so marked in the second experimental year. On the basis of two harvest years there were 14 significant comparisons within families. Eight families representing 26, I_4 polycross progenies contained 10 lines which were significantly poorer than their respective parental progenies. Four families containing 12, I_4 polycross progenies yielded 4 lines which were significantly superior to their parental progenies, while there were no significant comparisons in the six remaining families which contained 14, I-4 polycross progenies. The correlation coefficient between the yield of the parental polycross progenies and the average yield of their I_4 progenies was highly significant ($r = +.69$). This indicates that a fair relationship exists between the response of the parents and their I_4 lines.

The data suggest that some lines may be isolated in an inbreeding program which are better or poorer combiners than the original selections. In general, however, one might expect that the combining ability of the majority of I_4 lines would not differ materially from that of the parental clones. Thus it should be feasible to utilize inbred lines in the production of synthetic varieties to insure greater uniformity with respect to important economic characters.

In order to obtain further information on the effect of inbreeding on combining ability, I-5 lines and their parental clones were crossed onto two testers (1949 Annual Report, page 39). These progenies were space-planted in the spring of 1950, and individual plant yields will be taken in 1951.

At present the specific combining ability of I-5 and I-6 orchard grass lines is being investigated with a view to obtaining experimental evidence on the practicability of using inbred lines in the production of synthetic varieties. Eight parental clones representing four good and four poor clones, classified on the basis of their

polycross progenies, were brought into the greenhouse for diallel crossing. In addition, 15, I-5 lines isolated from these clones will be crossed in all possible combinations. Sixteen I-6 lines derived from the same source material will be treated in a similar manner. A total of 393 plants is included in the project.

A total of 2500 plants representing 115 I-6 lines from 19 families was planted in the spring of 1950.

Comparison of clonal, polycross and single cross progeny tests for the evaluation of individual plants of Dactylis glomerata: Additional single cross seed was harvested from the thirty-one plots isolated in wheat fields (1949 Annual Report, page 40). Observational notes taken in 1950 indicated that considerable variation in vigor and susceptibility to disease exists between the progenies included in the three seed sources (single cross, restricted polycross and large polycross) as well as between the parental clones.

Selection for persistency in Trifolium repens: Severe killing in the winter of 1949-50 reduced the Ladino clover population to the point where reliable data could not be collected from the preliminary field experiment, designed to test the field response of clones which tolerate low light intensity (1949 Annual Report, page 40).

One hundred plants representing six good and six poor clones, classified on their reaction to low light intensity, were brought into the greenhouse in the fall of 1950 for crossing. This seed will be used for artificial greenhouse tests and for establishment tests under field conditions.

Isolation of Ladino clover plants resistant to Sclerotinia trifoliorum: Material that had been thoroughly evaluated in artificial inoculation tests was brought into the greenhouse in the fall of 1950 for crossing. A total of 220 plants is included in this project representing 34 clones belonging to the following classifications: 17 partially resistant, 6 intermediate, and 11 susceptible.

Because insufficient material was available for extensive field plantings in the spring of 1950, additional field tests are planned for 1951 (1949 Annual Report, page 41).

Preliminary artificial tests are in progress with a limited number of single cross progenies representing combinations of the three categories listed above.

Genetic Investigations

Inheritance of maturity in Dactylis glomerata: Notes were taken on approximately 11,000 spaced plants representing various generations derived from crosses between one late and two early maturing clones. The generations included the parental clones, the F_1 clones, F_1 seedlings, backcrosses to both parents and the F_2 (1949 Annual Report, page 41).

The developmental stages studied included the number of days from initiation of growth in the spring to heading, the number of days from heading to flowering and the number of days from flowering to complete maturity (seed-ripe). Records were also taken on plant height and recovery after clipping. All data were recorded and analyzed in terms of individual plants.

The stages as defined in this experiment apparently represent sub-characters of a time-for-maturity character. The first two intervals were negatively correlated in most populations, but the degree of variation encountered suggests that the second interval is not governed entirely by the pleiotropic action of the genes which control the first interval.

There would appear to be at least six or seven major factors which influence the period from initiation of growth to maturity (seed-ripe). The means and genetic variances estimated for the three developmental stages suggest that both phenotypic and genic dominance are intermediate. Theoretical ratios approached the observed data best when chromatid assortment was assumed and all genes were considered to exhibit dosage effects which were approximately arithmetic.

The data accumulated on height and recovery after clipping indicate that these factors should be investigated in experiments that have been designed for this purpose. (Analysis of these data presented as a doctoral dissertation to the Agronomy Department of The Pennsylvania State College).

Inheritance of quantitative characters at the diploid and tetraploid levels in Dactylis sp.: Additional seed for this project will be obtained from 300 plants which were brought into the greenhouse in the fall of 1950 for crossing. At present one complete series is available for this project, i.e. the parental and F_1 clones at the 2x level and 4x level. Two other series consist of the parental and F_1 clones at the 2x level only (1949 Annual Report, page 42).

Considerable difficulty has been experienced in inducing tetraploidy by treating tillers with colchicine in order to obtain similar material at the 2x and 4x levels. A wide range of concentrations (.01%-.2% colchicine) and times have been tried, but in general most of the plants isolated have been mixoploid. Chromosome counts have been made on 750 plants.

Inheritance of male sterility in Dactylis glomerata: Approximately 2,000 plants representing F_2 and backcross generations were planted in the spring of 1950.

In order to investigate the effect of the environment prior to anthesis 12 clones were selected as examples of the following classes - complete male fertility (3), partial fertility (3), partial sterility (3), and complete sterility (3), (1949 Annual Report, page 42). When these plants reached the early boot stage they were subjected to two different temperatures in the control chambers (80° and 60°F.). After they were fifty percent in head the plants were interchanged to give four treatments - continuous high, continuous low, high to low and low to high.

The results of this experiment indicate that temperature has a marked effect on the expression of male sterility. The classification was not affected materially if the heads in question had emerged from the boot prior to exposure to the high temperature. On the other hand, exposure when the head was still in the boot tended to increase the expression of male sterility. In general, completely male sterile plants remained sterile, partially sterile plants could be changed to complete sterility while the expression of partial fertility could be altered to complete fertility.

There is some indication that the results obtained to date may be more intelligible if the partially sterile individuals are grouped with the sterile category, while the partially fertile plants are classed with the fertile category.

Inheritance of anther color in Dactylis glomerata: Approximately 2000 F_1 plants were established in the field in the spring of 1950 (1949 Annual Report, page 43). This material will be classified before producing other generations.

Inheritance of immunity from crown rust in diploid Festuca elatior: No seed was available for further inoculation tests since the fescue plants brought into the greenhouse in the fall of 1949 headed very poorly. In an attempt to promote better heading the 285 fescue plants that were brought into the greenhouse in the fall of 1950 were maintained at low temperatures immediately preceding exposure to long days (alternating 65° F, day, and 50°F, night, for four weeks followed by 50°F, constant, for two weeks). This treatment was successful in promoting floral initiation and heading.

Inheritance of leaf coloration in Trifolium repens: Seed produced in the winter of 1949-50 (1949 Annual Report, page 43) is being grown and classified in the greenhouse. The characters purple midrib and purple fleck, can be easily recognized in young seedlings. In order to accentuate the expression of purple leaf, however, it is necessary to maintain the seedlings at 50°F.

Cytological Investigations

Origin of aneuploidy in Dactylis glomerata: The variation in expression of morphological characters was studied in fifty-two representatives of ten aneuploid series. (1949 Annual Report, page 44). Insofar as possible the following chromosome numbers were included within each series: 26, 27, 28, 29, 30 and 31. No marked differences were encountered in height, width of leaves, amount and distribution of pubescence, type of panicle, size of florets, and color of plants.

Polycross tests of hexaploid Dactylis glomerata: A revised hexaploid polycross was planted in the fall of 1950. Studies are being conducted on the relationship of meiotic irregularity to seed production (1949 Annual Report, page 44).

Table 10. - Chromosome counts of seedlings grown from open-pollinated seed produced on two plants from each of six hexaploid progenies.

Progeny Number	Plant Number	Seedlings Examined	Chromosome Number 42	39	36	35	33	32	31	28
2	1373(2)	15	15							
2	1381(3)	15	15							
4	1391(1)	15	13			1	1			
4	1400(2)	15	12			3				
5	1381(8)	15	11			1		1	1	1
5	1400(4)	15	9	1	1	4				
7	1390(7)	15	10			5				
7	1400(5)	14	11		2	1				
11	1374(1)	15	15							
11	1384(3)	14	14							
20	1375(6)	15	13	1						1
20	1382(2)	15	15							
Total		178	153	2	3	15	1	1	1	2

Variation from the hexaploid number probably arose in one of the following ways (a) fertilization of a haploid egg (n = 21) w ith pollen (n = 14) from adjacent tetraploids, which would give the second prominent class, 2n = 35; (b) fertilization of aneuploid female gametes with pollen (n = 14) from adjacent tetraploids; and (c) union of two aneuploid gametes.

It is obvious from the chromosome counts listed above that hexaploidy does not constitute an effective isolation barrier. Similarly, if hexaploid strains prove to have superior qualities there would be a definite need for selection directed toward greater meiotic regularity.

Hybridization of Lolium perenne and Festuca elatior: Inferior heading limited the hybridization program planned for the winter of 1949 (1949 Annual Report, page 44). In the fall of 1950, 162 plants were brought into the greenhouse to continue the project. This material has been subjected to the same pretreatments outlined above for the fescue clones involved in the inheritance of rust resistance. The pretreatment has proved to be very satisfactory in inducing floral initiation and heading.

Interspecific relationships in Bromus sp.: Hot water emasculation at 45° to 47°F for 5 minutes has given satisfactory results with several species, depending on the stage of development of the florets when the treatment is applied. In the winter of 1950-51 hand emasculation is being used to supplement the bulk emasculation methods. A survey of the meiotic behaviour of the Bromus sp. included in this project is being continued. A rapid smear technique has been devised to facilitate the counting of somatic chromosome numbers. This procedure consists of collecting and leaving root tips in aceto-carmine for 30 minutes; heating in a drop of aceto-carmine followed by maceration and smearing in aceto-carmine.

Interspecific relationships in Phalaris sp.: A collection of eight Phalaris species was made in the fall of 1949 with a view to determining interrelationships within this genus. A survey of the

variation in somatic chromosome numbers is being conducted in a wide collection of Phalaris arundinacea, as well as in samples from each collection of the remaining species. The meiotic behaviour of these species is also being examined.

The cytogenetics of a reciprocal translocation and fragments in Dactylis glomerata: Collections have been made for pollen and meiotic analyses from more than 200 F_1 plants, representing crosses between normal plants, a plant identified as possessing a reciprocal translocation and six plants which possess fragments.

PATHOLOGY

Preliminary Disease Survey

Several disease survey trips were made in the vicinity of State College, Pennsylvania during October and November to determine the prevalence of foliage diseases on forage and pasture crops. Clover and alfalfa particularly were severely attacked by several leaf spot organisms. Stemphylium leaf spot (Stemphylium sarcinaeforme) and Pseudopeziza leaf spot (Pseudopeziza trifolii) were dominant in most fields of red clover. Alfalfa in this area was severely infected with Ps. medicaginis while leaf spots caused by Pleospora herbarum and an unidentified species of Ascochyta were found in many fields.

Studies on Stemphylium sarcinaeforme

Isolations were made from Stemphylium lesions on red clover collected on the survey trips and the isolates compared culturally and pathologically. Only minor cultural differences were observed among ten isolates grown on various laboratory media. In preliminary tests of four isolates on 21 strains of red clover there were variations in pathogenicity of the isolates as well as susceptibility of the clover strains. Cultural differences could not be correlated with the variation in pathogenicity.

Development of Method of Inoculating Alfalfa with Pseudopeziza medicaginis

For the past several years, as an integral part of the alfalfa breeding program, clones of alfalfa have been selected and rated in the field for resistance and susceptibility to Pseudopeziza medicaginis and Ascochyta imperfecti. A rapid method of inoculation has been investigated in order to increase the effectiveness of this program and to study the inheritance of resistance to Ps. medicaginis. In preliminary tests the method of testing plants has given excellent results.

In November 1950 eighteen clones which varied in susceptibility to Ps. medicaginis were brought to the greenhouse and cut back to approximately four inches. After the new shoots were about twelve inches long, ten cuttings were made from each plant and rooted in flats of sand (130 cuttings per flat). When the cuttings had rooted, petri dishes of sporulating cultures of the organism were inverted on a wire frame over the dry cuttings. After six hours the flats were placed in a moisture chamber at 20-24°C. for two days, then removed to a greenhouse bench.

Disease readings were made after three weeks using the following system of classification:*

0 - immune
1 - non-sporulating lesions, no chlorosis, few in number) resistant
2 - non-sporulating lesions, no chlorosis, many lesions)
3 - non-sporulating lesions, chlorosis — intermediate
4 - both non-sporulating and sporulating lesions, chlorosis) susceptible
5 - sporulating lesions, chlorosis)

An example of the consistency of the method of inoculation is shown in Table 11.

Table 11. - Disease ratings of Pseudopeziza leaf spot on alfalfa cuttings

Alfalfa Strain	Cuttings 1	2	3	4	5	6	7	8	9	10	Ave. Disease Rating	Greenhouse Class	Previous Field Class
C189	0	0	0	0	0	0	0	0	0	0	0	R*	R
C192	0	0	1	1	1	1	0	1	0	1	0.6	R	R
C196	2	3	3	2	3	3	3	3	3	3	2.8	M	M
C188	2	3	5	5	4	-	-	-	-	-	3.8	S	S
C186	4	4	3	3	3	3	3	3	3	3	3.2	S	M

R - resistant
M - intermediate
S - susceptible

PHYSIOLOGY AND BIOCHEMISTRY OF PASTURE PLANTS

Reserve Studies on Grasses

Reserve studies in other years (1948 Annual Report, pages 41-42) have been concerned with the storage and depletion of reserve carbohydrates and nitrogen in the underground parts of grasses and with the effects of environmental factors on these changes. In 1950 an experiment was carried out with the purpose of comparing the carbohydrate content of clipped orchard grass plants of different reserve levels with the subsequent recovery of the plants as measured by new top growth. The different reserve levels were obtained by placing the plants under different conditions of temperature, light intensity, nitrogen nutrition, and frequency of clipping for 5 weeks previous to the uniform clipping treatment. Recovery was permitted under normal greenhouse conditions. Samples were gathered for yield and chemical analysis at six dates, the last being 5 weeks after the uniform clipping. Positive significant correlations were obtained between the stubble and root weights at the

*A variation of the classification used by Davis, R. L., Purdue, 1950, Unpublished thesis.

time of clipping and the subsequently developed new top growth, but no consistent significant correlations were found between the carbohydrate content and the new top growth. The relation of carbohydrate reserves to recovery from clipping needs further investigation.

Improvement in methods of analysis

Extraction of sugars from forage plants by cold 60-80% alcohol in the Waring blendor was complete, but hydrolysis of sucrose occurred during the process. With green plants it is necessary to destroy enzyme activity by first heating the tissue in boiling alcohol, after which the blendor may be used in an improved and rapid method of extraction.

Plant Climate Studies

During the past year the air temperatures determined with thermocouples at various heights from 3 inches to 96 inches were analyzed by Mr. Arthur N. Dodd (graduate student) under the direction of Dr. Hans Neuberger, Chief of the Division of Metereology, at The Pennsylvania State College. These data from 1949 include temperature recorded at 2-hour intervals from June to October inclusive at 3", 12", 24", 48" and 96", over a Kentucky bluegrass sod and at the 3 inch height over an orchard grass sward, Kentucky bluegrass sod, and bare soil from November to April inclusive. These data indicated that the differences in the mean monthly temperatures due to height over a Kentucky bluegrass sod are small but that the differences in the mean daily maximum and minimum temperatures at different heights are rather large. Temperatures near the surface of the grass may be as much as 10°F. higher during the day and as much as 10°F. lower at night than those 96 inches above the grass. The magnitude of these differences is influenced by factors such as wind movement and cloud cover but the general relationship held during all months. The largest differences occurred at the 3-inch, 12-inch and 24-inch height with the 48-inch height approaching very closely the 96-inch height. The type of ground cover influenced the temperatures at the 3-inch height, those over orchard grass showing greater extremes from maximum to minimum temperatures than those over a Kentucky bluegrass sod or bare ground. When snow covered the thermocouples, these differences disappeared.

On the basis of the above data it was concluded that records of daily maximum and minimum temperatures at heights of 3 inches and 72 inches over a standardized Kentucky bluegrass sod (cut back to 1 inch when 2 inches high) would provide the essential temperature data to be taken at various experimental sites.

A commercially available relative humidity sensing element was adapted for use in growing vegetation. Records obtained on several preliminary runs over a Kentucky bluegrass sod indicated that relative humidity at the 3-inch height remained at 100% longer after sunrise in the morning, began to increase earlier in the afternoon and reached 100% two to six hours earlier in the evening than at the 24-inch height. Thus, even though both locations indicated the same extremes in relative humidity during the day, the sensing element at the 3-inch height was under a higher relative humidity for a longer time than the element at the 24-inch height.

For recording wind velocity an improvement over the extremely delicate thermistor element (1949 Annual Report, page 50) is now being investigated. This new sensing element consists of a number of thermocouples heated with an alternating current and since only the difference in temperature between the hot and cold junction is recorded, compensation for ambient temperature changes is automatic. This anemometer is extremely sensitive at low wind velocities of 1/2 to 5 miles per hour, but is equally effective although less sensitive at higher wind velocities of 10 to 40 m.p.h..

Growth Responses of Ladino Clover Clones under Low Light Intensities

In a continuation of this investigation (Annual Report, 1949, page 49) low light intensity tests were repeated using 57 of the 125 clones that had been tested plus 10 new clones. The light and growing conditions used were similar to those of the previous year except that an attempt was made to keep temperatures somewhat lower (about 80°F. during the daytime and 70°F. at night). There was close agreement between the results obtained in 1949 and 1950. Of the clones not previously tested two were outstanding not only in their survival for more than 100 days under the low light intensity, but in actual increase in size.

Observations during the trials suggested that the growing temperature may be an important factor affecting the responses of the various clones. To study this point a preliminary experiment was conducted in the climatic chambers using alternating temperatures of 70-85°F, 60-77°F., and 55-70°F., and a light intensity of 100 foot candles. Three clones that had shown good survival in the 1949 test, four clones that had shown about medium survival and those that had shown a poor survival were used. Results of these trials indicated that in general the best growth under low light intensity was obtained at the lower temperatures and that under the same light, but higher temperatures, growth of certain clones was poor and other clones died. It was interesting to note that while one of the "good" clones died within a short time at the 70-85° temperature, it actually increased in size at 55-70° whereas another "good" clone grew well at all temperatures. Most of the "poor" and "medium" clones maintained their same standing in this test with the exception of one "medium" clone which almost died at higher temperatures, but was superior to all other clones at the 55-70° degree temperature.

It appears from this preliminary experiment that a marked interaction between temperature and light intensity is present as measured by plant growth.

Rate and Frequency of Potash Applications on Dactylis glomerata

The availability of potassium applied at various rates and frequencies on plots of orchard grass was determined from potassium removed in the clippings (1949 Annual Report, page 52). All plots received a uniform application of nitrogen fertilizer to insure moderately good yields.

The calculated potassium recovery the first year averaged about 40 percent on plots receiving 60 to 120 pounds of K_2O per acre. A marked carry-over was obtained in 1950 from potash applied in the spring of 1949.

PART III

PASTURE RESEARCH AT STATE STATIONS

Storrs (Connecticut) Agricultural Experiment Station

Title: Alfalfa Experiments

Leaders: B. A. Brown and R. I. Munsell

(a) Fertilization: In 1950, the fourth harvest season for the present twenty-two treatment layout at Storrs, the only appreciable differences in stands or yields of dry matter were marked decreases where no potash had been added since 600 pounds per acre of 60% muriate of potash was applied before seeding in August 1946. The total yields of dry matter from three cuttings in 1950 varied from 81 to 110 cwts. per acre. Other treatments include: No P since 46% superphosphate at 400 was applied before seeding; the addition of sulfate of ammonia at 200 pounds in April and June; calcic instead of dolomitic limestone; limestone at 2 rather than 1 ton per acre in 1946; borax at 0, 5, 10, 20 and 40 pounds; and omission of Mn or Cu or Zn or Mo.

Analyses of pure alfalfa of 1949 show that K and B were higher in first than in second cutting while the reverse was true of Ca and Mg. The second cutting grew during parts of June and July, months which had the least rainfall for that period in sixty years. During this drought, the acre yields of dry matter for twenty-two different fertilizer treatments varied from 2270 pounds to 3131 pounds and averaged 2835 pounds.

Table 12. - The B analyses of 1949

Borax applied Before Seeding in July 1946 (Lbs. per Acre)	B in Dry Matter of Pure Alfalfa 1949 1st Cut (p.p.m.)	2nd Cut (p.p.m.)
0	15	14
5	19	15
10	20	14
20	23	18
20*	24	18
40	20	19
40*	25	18

*Half of borax plowed under; all other disked in.

These analyses emphasize the effects of dry weather on absorption of B and also that plowing under half the borax did not increase absorption, even during a drought.

The concentration of Ca in alfalfa tended to be highest where there has been no application since 1946 of K or calcic limestone or double rate of dolomitic limestone. There appeared to be no relationship between B and Ca concentrations.

The percentages of Mg were likewise highest where no K has been added since 1946 or where double the amount of dolomitic limestone was applied, but lowest under the calcic limestone treatment.

As might be expected, K was lowest where no muriate of potash was added since 1946.

In feeding trials conducted by the Dairy Department at Storrs to explain the poor growth of calves and milk production of cows in a few herds in Connecticut, it has been found that lambs fed hay (mostly alfalfa) with a high K, low Ca content, obtained by applying unusually large amounts of muriate of potash, retained less Ca and their blood contained less Ca than similar lambs fed normal hay.

(b) Varieties: At the end of three harvest years, a variety of alfalfa from a Station in France had the best stand (95%) and largest yield of dry matter (average 9500 pounds per acre). It also had the least leaf-spot in September but about an average amount in July. On the other hand, it had the coarsest stems. Since the test field had probably never grown alfalfa before, its resistance to wilt has not been determined here.

In July, two of the four Common varieties had by far the most leaf-spot, but in September the two strains of Ranger were the worst and in fact so badly infected that they were nearly defoliated. Buffalo had the least leaf-spot in July but more than the French variety in September.

Ladak has proved unsatisfactory for Connecticut conditions, chiefly because of such slow recovery after cutting that grasses and weeds have an opportunity to grow unimpeded. It had only a 45 percent stand at the end of the third year (September 1950). Its three year average yield of dry matter was the lowest of fourteen strains (7500 pounds per acre).

The Argentine, Atlantic and three strains of Common had above 90 percent stands in September 1950. Cossack, Meeker Baltic and Ontario Variegated had somewhat poorer stands and yields than three of the four "Commons". Next to Ladak, a Common strain from Montana had the poorest stand and yield. In this test, no wilt has been seen on any of the varieties, but it is very prevalent in Connecticut on fields where alfalfa has been grown several times.

Title: The Maintenance and Improvement of Pastures

Leaders: B. A. Brown and R. I. Munsell

The Effects of Fertilizer Treatments on the Soil, the Flora, and the Production as Measured by Grazing: For the second consecutive year, the two-acre plot fertilized with poultry manure at 2 tons in the fall of 1947 and 1948, produced as much feed (TDN as measured by grazing) as any of the seventeen pastures in this experiment. (See also co-operative renovation experiments on pages 23 and 24).

The Adaptability of Varieties and Species of Grasses and Clovers for Pastures: After ten complete seasons of ten cutting systems on the Ladino-orchard grass and Ladino-timothy seedings of 1939, the experiment

was terminated at the end of 1949 (see previous reports for summaries of results). In 1950, however, all plots were tractor mowed alike to measure the residual effects of the long time, differential cutting systems.

There were indications that the uniform mowing of 1950 started an equalizing trend in the markedly different stands of Ladino between cutting 2 inches or 4 inches above the ground. Nevertheless, on the timothy (mostly volunteer Kentucky bluegrass)section, the total yields of dry matter on the 8-2 and 10-2 inch plots with 59 percent Ladino, averaged about 30 percent greater than the 8-4 inch and 10-4 inch systems with 18 percent Ladino; on the orchard grass part, the corresponding Ladino stands were 60 and 34 percent and the yield difference was 20 percent.

In none of the previous ten years had there been any appreciable differences in the average yields between the timothy (Kentucky blue) and the orchard grass parts of the field. In 1950, however, the four cuttings totaled 54 cwt. for orchard grass and 45 cwt. of dry matter for timothy (Kentucky blue). The differences in favor of orchard grass were consistently much greater where the previous mowing was 4 inches rather than 2 inches above the ground and especially where mowing had terminated early in the fall. Since the chief apparent differences between the orchard grass and timothy plots with the 4 inch cutting systems from 1940-49 were that the stands of Ladino were better with orchard grass, the importance of this legume is further emphasized.

Grasses to Seed with Ladino: During the very dry August of 1949, each of sixteen kinds of grasses was seeded with Ladino clover. Although grasses are rightfully considered secondary to the legume in mixed seedings for pasture, it is important to have a grass which will become established quickly to protect Ladino through the first winter and increase the yields and balance the forage nutritionally during the initial harvest season. In this test, Ladino came through the winter best with Alta fescue and Kentucky bluegrass, the two grasses with thickest stands in the fall and early spring. In this respect, Lincoln brome was superior to six other bromes. The first cutting (June 12) yields corresponded to the stands of grasses and varied as much as 50 percent because of this factor.

During the driest period, the orchard grass-Ladino mixture produced the most forage, while most of the bromes were relatively low.

On the other hand, any species that competes too strongly with Ladino early in the season is likely to reduce mid-summer growth. For example, including red clover in a Ladino-orchard grass seeding resulted in the largest first cutting, but the smallest second crop. It is possible that some perennial grasses may compete too much with Ladino in later years, but in the ten-year management experiment at this Station, neither Kentucky bluegrass nor orchard grass afforded too much competition if mowed low--two inches above the ground.

In the 1930's, many persons concerned with pasture improvement thought that Kentucky bluegrass or other small grasses were inferior to larger grasses, such as orchard grass or brome. In the Ladino management experiment at Storrs (mentioned above) the average yields of dry matter for eight different systems over a ten-year period were practically the same where either Kentucky bluegrass or orchard grass accompanied the clover. Many more "management" experiments are needed to answer such questions.

Seasonal Production of Ladino-Grass Mixtures: For several years, this Station has been using the following so-called "standard" distribution of pasture production for Ladino-grass seedings, receiving no fertilizer nitrogen:

Month -	May	June	July	August	Sept.	Oct.	Total
Cow Days -	40	40	34	26	14	6	160

These values were based on the long time mowed yields of Ladino seedings at Storrs and on the assumption that 25 pounds of dry matter or 16 pounds of digestible nutrients is equivalent to a "cow day".

Table 13. - Distribution of yields from 132 fertilizer plots and 76 seed mixture plots of Ladino clover - grass in 1950

Dates	June 5-14	July 13-19	Aug. 17-23	Sept. 25-29	Total
Dry Matter (cwts./acre)	25	14	10	13	62
Cow Days (per acre)	100	56	40	52	248

It should be pointed out that the yields of dry matter would have been quite different in 1950 if the first cut had been made seven-ten days earlier or before some of the earlier grasses had started to head, and also if the driest period had not occurred between the second and third cuttings.

Fertilizing Ladino clover: During the twenty-one years Ladino clover has been tested at Storrs, many fertilizer trials have been conducted. On the basis of those trials, recommendations to farmers have been made and have proved reasonably sound. In recent years, however, new questions have been raised and to obtain information on them, another experiment was started during the summer of 1949. A Ladino clover-orchard grass mixture was seeded uniformly on a field divided into 132 40 x 15 foot plots on which 44 different fertilizer treatments in triplicate were applied. Before treatment, the soil was moderately acid (pH 5.7) and low in Ca, P and K. Four tractor mowings were made in 1950. The following statements are based on the 1949-1950 results:

(1) The best seedling growth and stands of Ladino occurred where at least moderate lime and potash, plus very heavy superphosphate (400 pounds P_2O_5) and no N had been added.

(2) Of the 44 treatments, the eight with raw rock phosphate (highest rate, 1800 pounds) had the poorest stands of Ladino and ranked 35, 36, 37, 40, 41, 42, 43 and 44 in yields of dry matter. Lime was omitted from one of the rock phosphate treatments.

(3) The highest yields were obtained from unusually large applications of limestone, superphosphate and muriate of potash.

(4) Nitrogen before seeding and after the second cutting stimulated the grass noticeably, but had little influence on total yields.

Other questions to which it is hoped answers will be obtained from this six-year experiment are:

(1) Should potash be applied every sixth year, third year, annually, after each cutting, and if annually, after which cutting?
(2) Annual versus very infrequent applications of superphosphate?
(3) Will very heavy liming reduce luxury consumption of potash?
(4) Effectiveness of TVA phosphates?
(5) Effects of plowing under or sole placement versus disking in of phosphate and potash?

Causes of Fluctuations in the Prevalence of White Clover: In the tenth year of the cutting management trials with two Ladino-grass mixtures, 18 plots mowed 2 inches above the ground averaged three times as much Ladino as 18 other plots mowed 4 inches above the ground (52 to 17 percent).

In another field, there was very markedly less native white clover near rocks where the height of mowing was considerably above that for most of the area. Thus, for Connecticut conditions, at least, height of mowing is one very important cause of fluctuating stands of white clover.

The annual fertilizer treatment for all of the cutting management plots was 70 pounds of P_2O_5 and 150 pounds of K_2O per acre. The soil had been limed to about pH 6.0. That rate of fertilization has maintained good stands of Ladino clover where other factors were favorable. On another field with stands of native white clover and grasses, mowed in early June for hay and grazed periodically thereafter, nearly 100 fertilizer treatments have been under test for twenty years. Under those conditions, there have been large amounts of clover where limestone at 1 ton has been spread once every four-five years and 40-80 pounds of P_2O_5 (from superphosphate) and 80-160 pounds of K_2O (from muriate of potash) has been applied annually. Thus, medium to high amounts of both P and K on moderately limed soil are required for thrifty stands of white clover on one of the most common soil types on livestock farms in Connecticut.

It is felt there are other important factors besides cutting and fertilization, but they have not been studied at this Station.

Delaware Agricultural Experiment Station

Title: Fertility Requirements of Legume and Grass-Legume Mixtures

Leaders: W. H. Mitchell and L. J. Cotnoir, Jr.

This study will consist of two closely related phases, namely,

(1) the fertility requirements of an orchard grass-Ladino clover mixture, (2) effect of subsoiling and deep placement of fertilizer on yield and longevity of legumes.

Phase 1:
We are primarily interested in determining the most desirable ratio and rate of fertilization to maintain a proper balance between grasses and legumes in addition to producing maximum yields.

This work is conducted at Newark, Delaware, on a Sassafras loam soil. The plots are arranged in a randomized block design and are replicated four times. Orchard grass and Ladino clover was seeded in September, 1949, and in March 1950. The plots received the following fertilizer treatments:

N	50, 100, 200
P_2O_5	100, 200, 400
K_2	100, 200, 400

These treatments were applied in all combinations with the exception of the high nitrogen - low phosphorus - low potash ratios whichwere omitted. Additional treatments included manure, minor elements, and a split application of potash. All plots were mowed with a power mower from about six inches down to two inches.

The results of the 1950 work have not been completely analyzed.

Phase 2:
With the aid of a fertilizer attachment on a subsoiling machine we have placed fertilizer at an 18 inch depth in the soil in bands 18 inches apart. This work is being done on two farms near Newark, Delaware, on Sassafras loam and Fallsington loam soils. The seeding mixtures consist of alfalfa, Ladino clover, alsike clover, red clover, timothy and bromegrass.

The fertilizer treatments are dolomitic limestone, 20% superphosphate, rock phosphate, 0-20-20, and 5-20-10 applied in various combinations. Subsoiling only and no treatment serve as check plots.

During 1950 there were no significant differences in yield showing from any of these treatments.

Maine Agricultural Experiment Station

Title: Evaluation of Forage Plants, Clones, Lines, Varieties, and Hybrids Developed by Plant Breeding

Leaders: C. H. Moran, H. J. Murphy

The first harvest year's results have been obtained from the observational nursery established at Stillwater in 1949. Legumes suffered severe losses during the winter of 1949-1950. The majority of the alfalfa, red clover, alsike and Ladino selections were killed. Grasses were not affected seriously.

A second observational nursery was set out on Aroostook Farm in Presque Isle.

Title: Management Practices as They Affect the Productivity and Persistence of Ladino Clover - Grass Associations

Leaders: C. H. Moran, H. C. Dickey, H. J. Murphy

Twelve pasture plots of Ladino clover-grass combinations located at Stillwater were severely injured during the winter of 1949-1950. Excellent stands of Ladino were reduced to stands of 20% or less. There seemed to be no correlation between previous management and severity of clover loss.

It was necessary to remove all livestock from the paddocks on August 2 because of lack of feed. Paddocks were disked lightly as preparation for an early spring reseeding of Ladino clover.

Title: Pasture Irrigation

Leader: R. A. Struchtemeyer

During 1950 a pasture irrigation experiment was conducted in central Maine. A field of 6.4 acres, comprised of a low quality legume grass seeding, was divided into two 3.2 acre fields. The two areas were treated identically except that one area received 5-1/2 inches of supplementary water. This additional water increased the dry matter yields from 519 pounds per acre to 2547 pounds and increased the total milk production from 2691 pounds to 7065 pounds.

Title: The Lignin and Cellulose Content of Some Grasses and Legumes Grown in Maine

Leader: B. E. Plummer, Jr.

The lignin and cellulose content was determined on samples of grasses and legumes grown for forage in Maine. Determinations of moisture, protein, fat, crude fiber, ash, and nitrogen-free extract by difference were also made on these samples. The lignin content of plants is considered indigestible and as cellulose is a more definite entity than crude fiber it has been suggested that the division of carbohydrates into lignin, cellulose and "other carbohydrates" is a more valuable method of representing the carbohydrates of a feed than crude fiber and nitrogen-free extract. A large part of the indigestible lignin may be extracted in the crude fiber determination and included in the nitrogen-free extract and not included under crude fiber. A portion of the cellulose also may be included under nitrogen-free extract.

Table 14.-The average percent carbohydrate composition of 36 samples of legumes and 24 samples of grasses.

Type of sample	Usual Method		Suggested Method			
	Crude Fiber	N.F.E.	Lignin	Cellulose	Other Carbohydrates	Total Carbohydrates
36 legumes	23.27	41.43	7.78	25.27	31.65	64.70
24 grasses	33.19	44.68	8.87	41.66	27.24	77.77

It is evident from the results that not all of the lignin and cellulose is reported as crude fiber in the usual method of feed analysis but a considerable amount is reported as nitrogen-free extract. The cellulose content of grasses was much higher than that of legumes, probably due to the higher xylem content. The results suggest that much more cellulose from grasses is reported as nitrogen-free extract than from legumes.

The lignin content for both grasses and legumes increased as the plant reached maturity. A low of about 4 percent lignin was found in young Ladino clover and a high of about 13 percent lignin in very mature medium red clover.

Title: Utilization of Radioactive Phosphorus by Clover

Leaders: G. L. Terman, P. N. Carpenter

In a greenhouse pot experiment with medium red clover, the effect of liming upon the uptake of phosphorus from a virgin and a cultivated Caribou loam was measured by the use of radioactive phosphorus. The virgin soil tested low in available phosphorus and the cultivated soil high as a result of accumulation of phosphorus residues from fertilizer applied for potatoes. The pH of the soils was 5.2 and 5.0, respectively.

Liming markedly increased the growth of clover and uptake of phosphorus on both soils, but increased the use of the phosphorus applied in this experiment on the low phosphorus soil only. On this soil about one-fourth of the phosphorus in the clover was found to have been taken from the fertilizer applied at the rate of 100 pounds P_2O_5 per acre, while nearly one-half was taken from the fertilizer at the 200-pound rate. On the unlimed high-phosphorus soil only about 15 percent of the phosphorus came from the fertilizer, and practically none on the limed soil.

Maryland Agricultural Experiment Station

Title: Orchard Grass and Bromegrass for Forage with Legumes

Leaders: For the Maryland Agricultural Experiment Station - A. W. Burger, T. S. Ronningen, A. O. Kuhn

Third harvest year clipping yields based on the difference between grazed and ungrazed caged areas on triplicate plots of orchard grass in mixture with alfalfa, red clover, and Ladino clover as compared to Lincoln bromegrass with these same legumes were 2.5 tons of dry matter per acre for the orchard grass plots and 2.1 tons of dry matter per acre for the bromegrass plots. The orchard grass plots were almost entirely orchard grass and Ladino clover while the bromegrass plots consisted of predominantly Ladino clover alone. Further, it was noted that the orchard grass-Ladino clover mixture was very desirable in that the sward was composed of satisfactory proportions of grass and legume. Beef animals were used to graze these paddocks.

Title: Red Clover Breeding

Leaders: C. H. Liden and O. D. Morgan, Jr.

Tests were continued during 1950-51 on development of resistance in red

clover to anthracnose. Seed used in these tests was from plants surviving similar tests in 1949-50 except that the clover varieties and selections used in 1950-51 were not inoculated with the root and crown rot organism, Sclerotinia trifoliorum.

Seed from selections made from field nurseries of 1950 was grown in 3-inch pots replicated 4-5 times. After several leaves were formed they were inoculated, in a controlled moisture and temperature chamber, with a mixture of 11 isolates of Colletotrichum trifolii. Results indicate a moderate degree of resistance in most lines. The check plants were all killed in 5 days, whereas most plants of all selected lines were still alive after 5 days and a few plants of some selections were alive after 10 to 12 days. After 10 to 12 days the plants were removed from the chamber. Survivors of the above tests will be transplanted to field nurseries this spring for further evaluation.

Superior plants in the field nursery have been selfed and crossed in certain combinations. The seedling progenies are among those being evaluated further for disease resistance.

Title: Red Clover Management to Maintain Stands

Leaders: A. O. Kuhn and R. J. Allen, Jr.

Sixteen variations in management of red clover stands following combining of small grain were used at four locations during each of two years, with four or five replications at each location. (1948 Annual Report, page 47, and 1949 Annual Report, page 56).

During both years the major stand losses occurred in the summer of the seeding year. Best maintenance of plant stands and highest yields of red clover in the year following treatment were obtained from plots where the straw, weed growth and clover growth were clipped and removed in late August or early September. This is in agreement with recent studies from other states. The yields of red clover obtained from plots receiving the treatments (1) mowed just after combining, everything removed, mowed early September, everything removed; (2) mowed just after combining, everything removed, mowed at 4 weeks, 6 weeks, and 12 weeks; (3) straw removed, clover cut at 1/2 bloom and removed, mowed again early September; and (4) mowed early September, everything removed, were approximately double those obtained from plots receiving the treatments (1) no treatment following combining; (2) the straw only removed, or (3) the straw not removed, the stand mowed in early November and growth left on the ground.

Topdressing of stands at all locations during July 1949 with five combinations of P_2O_5, K_2O, and a minor element mixture had no detectable effect on stand count or on yield of hay harvested from these areas in 1950.

Title: Alfalfa Variety Tests

Leaders: For the Maryland Experiment Station - T. S. Ronningen and A. W. Burger

Varietal behavior was varied throughout Maryland during the second-

harvest year. Ranger and Buffalo were superior in the north central portion of the state, and Williamsburg and Kansas Common were generally better at College Park. Atlantic and Williamsburg were slightly superior on the Eastern Shore, although varietal differences were smaller. Stands of Argentine were badly depleted at all locations. New tests were started near Hagerstown, in the northwestern portion of the state, and at College Park in the fall of 1950.

Title: Pasture Renovation Studies

Leaders: For the Maryland Agricultural Experiment Station -
A. W. Burger, T. S. Ronningen, A. O. Kuhn

Renovation studies to compare various grass-legume mixtures and disking versus shallow plowing for seed-bed preparation as well as fall versus spring establishment have been continued.

The 1950 comparative yields in tons of dry matter per acre for the four most promising mixtures are given in the accompanying tables.

It is apparent from the 1950 data, as was also true of the 1949 yields, that the addition of red clover and alfalfa to the orchard grass - Ladino mixture considerably increased especially first harvest year - and even second harvest year - yields of dry matter. Tall fescue in combination with Ladino clover, red clover and alfalfa shows some promise as a high yielding mixture especially in the first harvest year, although the invasion of species other than those originally seeded was more evident in the tall fescue than in the orchard grass mixture. By establishing these mixtures in the fall, there is more chance that the sward will be composed of a greater percentage of the seeded mixture than with spring establishment.

All mixtures involving Birdsfoot trefoil have been a failure insofar as dry matter yields and vigor are concerned.

Timothy and smooth bromegrass in forage combinations have been generally unsatisfactory in persistence and yields.

Table 15.-Average Dry Matter Production in Tons per Acre, 1950

	Established in Fall of 1949 (Average 2 Locations)		
	Disked	Plowed	Average Disked and Plowed
Orchard grass - Ladino clover	2.31	2.08	2.20
Orchard grass - Ladino clover - red clover	2.83	2.46	2.65
Orchard grass - Ladino clover - red clover - alfalfa	2.85	2.59	2.72
Tall fescue - Ladino clover - red clover - alfalfa	2.94	2.77	2.86
Average	2.73	2.48	2.60

Table 16.-Average Dry Matter Production in Tons per Acre, 1950

	Established in: Fall 1948 (Ave. 3 Locations)		Spring 1949 (Ave. 3 Locations)				
	Disked	Plowed	Disked	Plowed	Average Disked	Average Plowed	Average Disked and Plowed
Orchard grass - Ladino clover	1.91	1.82	1.49	1.30	1.70	1.56	1.63
Orchard grass - Ladino clover - red clover	1.95	1.96	1.83	2.07	1.89	2.02	1.96
Orchard grass - Ladino clover - red clover - alfalfa	2.13	2.21	2.06	2.68	2.10	2.45	2.28
Tall fescue - Ladino clover - red clover - alfalfa	1.95	2.17	2.16	2.27	2.06	2.22	2.14
Average	1.99	2.04	1.89	2.08	1.94	2.06	2.00

Title: Grass and Legume Combinations for Beef Production

Leaders: For the Maryland Agricultural Experiment Station - A. W. Burger, T. S. Ronningen, A. O. Kuhn

Grazing trials were set up in the fall of 1949 and spring of 1950 to study the relative forage values of five pasture mixtures, namely, orchard grass - Ladino clover, tall fescue - Ladino clover, Kentucky bluegrass - timothy - white clover, smooth bromegrass - Ladino clover, and orchard grass - lespedeza. These various forages were rotationally grazed by Hereford yearling steers beginning July 10. The relative forage values of these mixtures are being determined in terms of beef and dry matter production. Two methods of measuring dry matter production are being used (1) the conventional cage method, and (2) the strip method. This grazing trial was established on rather infertile, poorly drained, idle soil in the tobacco area of Southern Maryland, where according to the USDA -SCS the most serious soil erosion problem of the state occurs. The entire grazing area was treated with 200 pounds of 3-12-6 fertilizer at establishment time. In order to study the effects of low and high fertility levels, one-half of the grazing area was treated with 400 pounds of 0-12-12 and the other half with 700 pounds of 0-12-12 fertilizer. Lime applications were made to bring the soil pH to 6.5.

Table 17.-The 1950 Results of the Beef Production and Dry Matter Production Studies for the Grazing Period July 10 - August 28 Inclusive

Mixture	Beef Production (Pounds of beef per acre)	Dry Matter Production (Tons per Acre) Cages	Strips
Orchard grass - Ladino clover	117.6	0.52	0.67
Tall fescue - Ladino clover	100.8	0.60	0.51
Kentucky bluegrass - timothy - white clover	90.8	0.38	0.48
Smooth bromegrass - Ladino clover	86.8	0.52	0.44
Orchard grass - lespedeza	82.0	0.31	0.42

Title: Microclimatic Environment of Common Forage Species

Leaders: A. Morris Decker, T. S. Ronningen, H. C. S. Thom, Department of Geography, cooperating

A microclimatic study is being superimposed on some of the plots in the NE-10 Uniform Strain and Variety Test. A 16-point recording potentiometer is now in operation measuring soil and air temperature at various levels in Ladino clover, orchard grass, Ladino-orchard grass, and standard bluegrass plots. In addition, a portable potentiometer has been obtained for making spot checks on the remaining plots of these species and on alfalfa and alfalfa-grass plots. Equipment is also being obtained and techniques worked out for taking relative humidity and light data in the herbage. Evaporation will be checked by the use of atmometer bulbs, and wind velocities will be recorded after suitable anemometers have been obtained. A recording rain gauge has been installed in the center of the plot area and has been in operation since November. Soil moisture will be periodically checked at 3-, 10-, and 18-inch levels by use of Bouyoucos blocks and a resistance bridge. Relationships of microclimatic and macroclimatic factors to plant growth responses will be noted.

New Hampshire Agricultural Experiment Station

Title: The Fertility Needs of Ladino Clover

Leaders: F. S. Prince, L. T. Kardos, and R. Feuer

Greenhouse studies were conducted using a Paxton loam topsoil with various levels of borax, lime and magnesium. The borax and lime levels were arranged in such manner as to determine the interaction of these two treatments. The levels of borax used were equivalent to 0, 4.3, 8.6, 17.2 and 34.3 pounds per 2,000,000 pounds of soil. The lime levels were equivalent to 0, 1 ton and 2 tons per acre and were combined with the various borax levels. The magnesium levels were equivalent to 0, 8.6, 17.2 and 34.3 pounds of MgO equivalent per 2,000,000 pounds of soil and were supplied as $MgSO_4$ $7H_2O$.

Six cuttings were obtained over a period extending from December 3, 1949, the date of seeding, to August 4, 1950. At the first cutting, a slight increase in yield was obtained up through 17.2 pounds of borax but with 34.3 pounds of borax the yield was no better than with the no-borax treatment. The plants in the 0-lime, 34.3 pounds of borax treatment showed what appeared to be slight boron toxicity in the form of a yellowish-brown margin on the older leaves.

After the first cutting, yield differences among the borax treatments became non-significant.

There was no obvious response of the Ladino clover to the Mg treatments, but there was a trend for slightly greater yields at any given borax level with increased rate of liming.

Title: The Influence of Pasture Irrigation under New Hampshire Conditions

Leaders: F. S. Prince, P. T. Blood, L. T. Kardos, K. S. Morrow, B. P. Kines

Pasture irrigation was continued in 1950 on a newly seeded field. This field had been plowed from sod in the autumn of 1949, and planted to rye. The rye was overseeded during the last week of March 1950 to Ladino clover, red clover and grass (timothy one section, bromegrass on the other). The rye was pastured twice, and clipped before irrigation started.

The pasture season to mid-August 1950 was very dry. April, with 2.46 inches of rainfall, had about three-quarters normal precipitation. May had 1.04 inches, June 1.77, July 1.17, while August had 5.55 inches or almost double the normal rainfall for that month. August precipitation did not come, however, until the 19th, so that from May 1 to August 19, a period of 111 days, the rainfall totalled only 3.98 inches, which is little more than a normal rainfall for one 30-day period.

Irrigation was begun on June 17 on specified areas. These areas consisted of four plots of approximately one-half acre each, two of which were designed to be used as "conditioning" pastures, the other two to be used as "experimental" areas on which milk yield from dairy cows might be recorded. Two four-foot square cages were set in each of the four areas to be irrigated, with an exact replica set up in a non-irrigated section of the pasture.

The irrigated areas were pastured twice, approximately at monthly intervals. Harvests from the cages were taken at the time of pasturing, and again in mid-October. The non-irrigated plots were not pastured, although the cages were harvested wherever there was any growth, in September and again in October.

Water was applied to the irrigated plots at intervals of a week or 10 days, with an average of about an inch being applied at each irrigation. The need for watering and the moisture conditions in the soil were followed by means of gypsum blocks, and by frequent sampling and drying.

Plot	Average Acre Yield Oven dry Material, All Harvests
Irrigated "E"	3340 Lbs./A.
Irrigated "C"	3468 Lbs./A.
Non-Irrigated All Plots	412 Lbs./A.

The average yields of all "E" and "C" plots under irrigation amounted to 3404 pounds of dry matter per acre. The difference between this figure and the yield of the non-irrigated plots was 2992 pounds per acre or almost one and one-half tons. On the assumption of 20 percent of dry weight the green weight yield becomes 15,000 pounds or 7-1/2 tons per acre.

As stated originally, these tests were conducted on a new seeding of clovers and grass. The fact that the irrigated sections of the field yielded 3404 pounds of weed free dry matter per acre indicates that a good stand was secured on these areas, whereas the 412 pound acre yield for the summer and fall season on the unirrigated areas shows that the stand there was almost a complete failure. This was true except for the low spots in the field.

Irrigation in this instance not only gave a good increase in yield, but probably made unnecessary a complete reseeding program on the area where irrigation water was applied.

Title: Maximum Use of Roughage in Feeding Dairy Cattle

Leaders: H. A. Keener, N. F. Colovos and H. A. Davis

Studies to determine the relative value of mow-cured hay, field-cured hay, wilted grass silage and molasses grass silage for growing dairy heifers were concluded. The forage used was a legume --grass mixture high in red clover. Corn silage was also fed in certain combinations. No concentrate was fed at any time. In general the lowest gains in body weight were obtained on hay and the largest on silage. Gains on combinations of hay and silage were intermediate. Although the highest dry matter intakes were obtained on mow-cured hay, the gains in body weight were the lowest. Gains of approximately 85% of normal were obtained with the all hay animals, 117% with the hay plus silage animals, and 161% with the silage animals.

Oat silage preserved with sulphur dioxide was found to be equal to if not superior to similar silage preserved with molasses. The SO_2 silage was very palatable and had superior keeping qualities during warm weather.

A trench silo was tried with very satisfactory results. A grass legume mixture was ensiled with molasses. One part of the trench was filled with chopped material, the remainder with long. Both made very excellent silage and the losses due to spoilage were very small.

Title: The Effect of the Maximum Use of Roughage upon the Reproductive Efficiency of Dairy Cattle

Leaders: H. A. Keener, K. S. Morrow and F. E. Allen with cooperation of K. C. Beeson, U. S. Plant, Soil and Nutrition Laboratory, Ithaca, N. Y.

This project is a phase of the regional sterility project (N.E. 1). Its

purpose is to study the relationship between a low mineral intake and the reproductive performance of dairy cattle. Starting with baby calves, the experimental animals are being fed in as far as possible on roughage produced on a restricted area under conditions which will lower the minor element content as much as possible. The plan of the experiment calls for three replications with both timothy and a Ladino-bromegrass mixture being grown on each. Three animals are to be assigned to each type of roughage on each replication and will remain on this particular roughage as long as they are on the experiment.

Species of forage sampled in the field and the forage as fed will both be analyzed for the various minor elements. The experiment is to continue for a period of ten years.

Calves have been on roughage produced on two of the replications for approximately six months. Marked cobalt deficiency has occurred in the calves fed timothy and there are indications of borderline deficiency symptoms in certain of the calves fed the Ladino-bromegrass hay. Other possible mineral deficiencies will be watched for during the progress of the experiment. The effects of individual mineral deficiencies will be studied in detail.

Title: The Relationship between the Diet of Dairy Animals, and Digestibility and Utilization of Protein and Energy, the Synthesis of Some of the B Vitamins and the Activity of the Flora of the Digestive Tract

Leaders: N. F. Colovos, H. A. Keener, A. E. Teeri, H. A. Davis, A. F. Howe

This comprehensive physiological study is being carried out along the lines indicated in the title. Various types of roughages preserved by various methods are being used. Only the results which deal with the digestibility and utilization of forage are reported.

Results of the past year indicate that the digestibility coefficients for both the protein and energy of silage are lower than for hay made from similar forage. Mow-cured hay was superior in digestibility of both protein and energy. There are preliminary indications, however, that the nitrogen from silage is retained in greater amounts than that from hay.

Title: Supplemental Vitamin D for Dairy Cows

Leader: H. A. Keener

This project has been concerned with a study of the vitamin D content of forage as affected by species, stage of maturity, season of the year, environmental conditions, and method of harvesting and storage. The project is being extended in an effort to determine if the wide variability encountered is due to the composition of the plant or to factors which affect irradiation.

Conclusive results cannot be given as yet.

New Jersey Agricultural Experiment Station

Title: Belle Ellen Pasture Experiment

Leaders: C. B. Bender and Claude Eby

Object: To obtain production values of tall growing grasses and legumes in a pasture sward.

Procedure: The Belle Ellen pasture area, comprising 45 acres is divided into pastures ranging in size from 3.4 to 7.2 acres. The pastures are rotationally grazed by 85 head of milking Holstein and Guernsey cows. A part of the herd is barn fed at some time during the grazing season.

Table 18. - Grazing records on the basis of a 1000 pound cow unit.

Pasture No.	Forage	Fert. Treat/A	1000 lb. cow days/A
		200 lbs. 10-10-10 Mar. '50	
B1-2	Orchard-Ladino	400 lbs. 5-10-10 Nov. '49	177
*B3	Brome-Ladino	400 lbs. 10-10-10 Mar. '50	107
B6	Kentucky bluegrass	500 lbs. 5-10-10 Mar. '50	164
B7	Reed-Canary-Ladino	500 lbs. 5-10-10 Mar. '50	231
B8-9	Bluegrass-White Clover	500 lbs. 5-10-10 Mar. '50	182
B11	Oats-Birdsfoot Trefoil	500 lbs. 5-10-10 Mar. '50	130
B13	Bluegrass	500 lbs. 5-10-10 Mar. '50	120
B14	Bluegrass	None	96
B15	Bluegrass	500 lbs. 5-10-10 Mar. '50	130
B17	Brome-Ladino	500 lbs. 5-10-10 Mar. '50	190

*B3-This pasture, an old bromegrass sod was disked twice in early spring following an application of 1 ton ground limestone and 400 lbs. 10-10-10 per acre. A broadcast seeding of 1 lb. Ladino and 2 lbs. medium red clover was made following the disking. The area was then cultipacked. This method of renovation produced 43% legumes by September 8, 1950. Total plant count was as follows:

Kentucky bluegrass 19.6 per cent, medium red clover 9, weeds 6.2, bare spots 5, Ladino 34, and bromegrass 26.2 percent.

Table 19.- Grazing records of the Lyker Farm area grazed by dairy heifers from May 3 to October 6, a total of 156 grazing days, reported in 1000 pound cow days per acre.

Pasture No.	Forage	Fert. Treat/A	1000 lb. cow days/A
W1	Bluegrass -white clover	250 lbs. $CaCN_2$ Mar. '50	121
W2	Bluegrass-white clover	1000 lbs. 5-10-10 Mar. 200 lbs. $CaCN_2$ June	163
W3	Bluegrass-white clover	500 lbs. 5-10-10 Mar.	59
W4-5	Bluegrass-white clover	500 lbs. 5-10-10 Mar.	150
W6	Reed Canary-Ladino	500 lbs. 5-10-10 June	245
W7	Brome-Ladino	500 lbs. 5-10-10 June	202
W8	Brome	500 lbs. 5-10-10 Mar.	131
W9	Brome-Alfalfa	500 lbs. 5-10-10 Mar.	125

Pasture No.	Forage	Fert. Treat/A	1000 lbs. cow days/A
W10	Brome	500 lbs. 5-10-10 Mar.	158
W12	Bluegrass-white clover	500 lbs. 5-10-10 Mar.	129
W13	Bluegrass-white clover	500 lbs. 5-10-10 Mar.	128
W16	Bluegrass-white clover	500 lbs. 5-10-10 June	182
W18	Bluegrass	500 lbs. 5-10-10 Mar.	94

Title: Studies of Reed Canary grass for pasture and hay

Leaders: M. A. Sprague, Claude Eby and C. B. Bender

Two years' trials indicate that Reed Canary grass cut at maturity makes an excellent bedding for dairy animals, with yields up to 3 tons of hay per acre. This crop may prove very valuable as a source of bedding in a grassland program, where no grains are grown. A fertilizer mixture of 400 pounds of a 10-10-10 seems to be indicated for maximum production. Some fall grazing is also possible on the aftermath.

Title: Ladino Clover Strain Tests

Leader: M. A. Sprague

19 Strains of Ladino clover originating from all of the major seed producing areas in the United States and including two samples imported from Italy were seeded on the College Farm in New Brunswick in April, 1949.

Data collected during 1950 indicate that those strains which are of Northern origin survived the winter 1949-50 best, whereas those strains grown in California and Italy survived the winter poorly. Seasonal yields collected during 1950 indicated that those plants which were the most vigorous were, in general, the least winterhardy. Weed infestation was, of course, directly proportional to winter injury inasmuch as the reduced stand during May and June permitted competition of summer weeds. There was little difference between strains with respect to leaf hopper damage. This study is by no means conclusive yet offers some indication of the relative merits of Ladino clover from seed grown in different sections of the country. There was no indication of mechanical dilution, of the Ladino clover seed planted, with common white clover.

Title: Winterkilling Studies with Ladino Clover

Leaders: M. A. Sprague and Glen M. Wood

This study was undertaken first in the fall of 1948 (Annual Report 1949, page 65). Three fall cutting practices were applied to three plant materials, namely clippings made on September 1, clippings made on September 1 and October 1, and clippings made on September 1, October 1 and November 1, such clippings to represent as nearly as possible grazing on those dates. Plant materials included 2 clones, one expressing considerable winter hardiness and the other

possessing moderate winter hardiness, plus a field run material consisting of a seeding of Ladino clover. Stolon samples drawn during January, February and March were analyzed for several carbohydrates. Other stolon samples were removed to the laboratory and subjected to freezing treatments. Subsequent survival growth in the greenhouse indicated damage inflicted.

In general, these studies have indicated that percentages of reducing sugars and polysaccharides decreased in Ladino stolons as the winter progresses while sugar and nitrogen contents increase. The more winter hardy clovers tested higher in most carbohydrates than did the non-hardy clovers, particularly with respect to polysaccharides. Severe fall cutting had a depressing effect on the levels of reducing sugars, hemicellulose, total polysaccharides, and nitrogen and had no effect on total available carbohydrates and starch contents. It was concluded that polysaccharides are the main carbohydrate reserve foods in Ladino clover. Field studies of growth characteristics indicated that greater fall dormancy is related to greater cold hardiness in Ladino clover. Fall cuttings applied to these trials had no observable effect on the survival following exposure to low temperatures. These studies are being continued.

Title: Utilization of Pastures in the Production of Beef

Leaders: Paul Grinde - M. A. Sprague

This project (1949 Annual Report, page 66) was continued a second season. During 1950, 16 steers averaging 570 lbs. were provided nothing but a 4 year old seeding of quality orchard grass-Ladino clover and bromegrass-Ladino clover pasture from April 28 to October 13, a total of 168 days. The average gain per steer was 1.62 lbs. per day, a total of 273 lbs. The average production per acre was 198 lbs. of beef plus 3.93 tons of silage in May. These data are consistent with those collected during 1949 and are considered an excellent yield for the 22 acres of reclaimed land under test.

Title: Forage Crops Investigations

Leaders: H. Douglas Gross and G. H. Ahlgren.

The alfalfa variety-fertility interaction test involves Ranger, Buffalo, Kansas Common and Atlantic alfalfas under twelve fertility treatments. The treatments are

0-50-50 + B*	50-200-200 + B	0-200-50 + B
0-100-100 + B	100-200-200 + B	0-200-100 + B
0-200-200 + B	0-50-200 + B	0-200-200 + B
25-200-200 + B	0-100-200 + B	100-200-200 + B

*Borax added at 50#/Acre

Four years' data collected indicate that Atlantic is the best variety in the test. It yields highest under 9 of the fertility levels, covering both low and high treatments. It has given the highest average in the test; 5246# D.M./acre for a four-year average. Kansas Common is the second best with an all-treatment average of 5046# D.M./Acre for four years. It also yielded the highest in 3 of the 12 fertility levels. Ranger and Buffalo yielded over-all averages of 4732 and 3798 pounds respectively. Among the fertility levels, the 0-200-200 treatment

has given the highest all-variety average to date: 5437#. Other yields are as follows: 0-100-200, 5267#; 0-50-200, 5157#; 100-200-200, 5124#; and 0-200-50, 4438#. The yield averages given are for a total of seven cuttings over the four years which are probably lower than field practice would be.

Potassium seems to be the limiting factor in all cases and is essential for persistence of the stand. Stand estimates have not been completed, but differences in the field are obvious.

Title: Time of Fertilization Study with Pastures

Leader: E. R. Purvis

Time of fertilization studies with pastures were undertaken on farms in 2 counties in New Jersey representing two soil types. The following table represents information collected during the first year of study.

Table 20. - Summary Data for 4 Harvests in 1950

Farm 1 - Chenango Silt Loam, pH 6.5

Treatment	Yield in lbs. dry weight per acre				
	Date of Harvest				Total Yield
	5/23	6/16	8/1	9/18	
No fertilizer	2185	392	1296	749	4622
*Fertilized in Nov.	2938	427	1105	770	5240
*Fertilized in Mar.	3363	278	1123	739	5503
*Fertilized in May	2084	1064	1328	673	5149

Farm 2 - Collington Sandy Loam, pH 5.3

Treatment	Yield in lbs. dry weight per acre				
	Date of Harvest				Total yield
	5/25	6/30	8/4	9/19	
No fertilizer	1550	798	596	526	3470
*Fertilized in Nov.	2140	855	433	601	4029
*Fertilized in Mar.	1769	895	562	720	3946
*Fertilized in May	1169	1370	526	622	3687

*750 lbs. of 5-10-10 per acre.

Title: Small Grains for Fall and Spring Pasture

Leader: M. A. Sprague

Trials undertaken to determine the use of small grains for pasture (1947 Annual Report, page 54) were continued to determine the response of rye, wheat, and oats to fall and spring grazing practices. Data were collected on forage yields and subsequent yields of grain and straw.

The three year average showed that rye produced 2617 pounds of dry forage per acre, wheat 1445 pounds, and oats 941 pounds when grazed in both fall and spring. The same relationship was found between the several grains when grazed in other ways with the exception of oats which yielded more in fall than in spring. A single spring grazing yielded 2381, 1382 and 748 pounds respectively. Converting these figures to yield of TDN per acre using Morrison's figures for digestion and assuming 16.3 lbs. TDN per acre requirement for a 1000 pound cow producing 28 lbs. of milk per day, it was found that rye provided 107 days of grazing during the fall and spring season's grazings. Wheat provided 57 days and oats 37.

The same responses were observed in 1950 as in previous years with respect to grain harvests following the grazing periods. The greatest reduction in grain yield followed spring grazing only. A combination of fall and spring grazing gave less reduction per acre in yield of grain than spring grazing alone.

Title: Pasture Renovation Studies

Leader: M. A. Sprague

Two new pasture renovations were established in New Jersey during 1950 utilizing conventional methods as well as searching for possibilities of the use of some soil sterilants in preparation of the sod for renovation.

Data collected from previous renovations and in Sussex County showed increased pasture production up to 243 percent on some areas. Areas which had been renovated utilizing Trichloroacetic acid as a sod preparer showed no regrowth whatever of Kentucky bluegrass, whereas 1 year after conventional renovation in this same trial, that is, where only disking was used, 10.8 percent of the 1950 foliage was bluegrass. Though the details of the use of herbicides in renovations have not been worked out in full it is felt that this principle has considerable merit in preparing a sod with less effort, primarily because a dead sod will respond far more readily to tillage equipment than a live sod and regrowth from a dead sod which has been disked will offer far less competition to developing seedlings.

Cornell University (New York) Agricultural Experiment Station

Title: The Evaluation of Forage Crops Varieties and Strains for their Use and Adaptation in the Northeast. Sub-project I: Evaluation of Forage Crops Varieties and Breeding Materials for New York (R&M Pl. Breed. 26-1, 9b1 and 9b2.)

Leaders: R. P. Murphy and S. S. Atwood

Report: (This report covers the fiscal year 1949-50 and it covers some of the studies reported under other projects in last year's report.)

Progeny testing of selected plants and other research conducted under this project will be reported here separately for each species.

A. Alfalfa

1. 1948 Nursery of Eastern, Northern and Rhizomatous Synthetics. These tests were described in the 1949 report. Notes on vigor, disease and insect reaction as well as yield data were obtained for two harvests in 1949. No significant differences in yield in the solid-seeded row tests were found. However, in the spaced plants the parental clones and their progenies showed significant differences in performance, especially for yield and disease resistance. As an example, clone C-22 proved to be quite undesirable in the Eastern Synthetic because of leaf spot and downy mildew susceptibility.

2. 1948 Ranger Increase Study. This study was described in the 1949 report. An intensive study of 30 different characters was made in 1949 by Mr. S. P. Kohli, a graduate student. From the studies no significant differences of economic importance were found among the different increases of Ranger.

3. 1948 New York Polycross Progeny Test. A few notes were taken on this spaced plant test. No great differences in performance were noted. This test will be used for a source nursery, since few of the parental clones seem to be of as great promise as material isolated more recently in the breeding program.

4. 1948 Uniform Advanced Nurseries. Two replicated plot plantings were made, one on the East Lankin field and one on McGowan. The planting on McGowan was harvested for yield and significant differences among varieties and new synthetics were found. The planting on East Lankin was noted for stand and vigor but because of a variable growth and a high infestation of annual weeds no yields were taken. This test was fertilized rather heavily, and good stands were observed in the fall of 1949; it is planned to harvest yields in 1950.

5. 1949 Uniform Advanced Nursery. This replicated plot planting of varieties, synthetics, polycross progenies and single crosses was made on the Underwood field and good stands were obtained.

6. Other Varietal Yield Trials are conducted at Ithaca and at several locations in the state under Plant Breeding State Project 9.

B. Bromegrass

1. 1948 Polycross Progeny Test. This replicated plot test of the polycross progenies from the best clones of the 1946 Polycross Seed Production Nursery was harvested for hay in 1949. Because of the very dry year and the extremely variable growth no afternath harvest was made. Significant differences in yield were found among the progenies.

2. 1949 Polycross Progeny Tests. Three different plantings were made and are described in the 1949 report. The initial stands and subsequent establishment only fair. However, it is felt that satisfactory stands will be present in the spring of 1950. These tests include the progenies of 54 clones from New York and 26 clones from the Pasture Laboratory, State College, Pennsylvania.

3. 1948 Isolation Plots of Eight Synthetics. These synthetics were described in the 1949 report. Very good yields of seed were obtained from all of these so that they can be tested widely. On the basis of notes taken on the replicated spaced clones in the synthetics of the I_1 families some of the parental clones will be discarded before seed is harvested in 1950. The number of clones which will remain in each of these synthetics are: Syn. E 15 clones, Syn. F 16 clones, Syn. G 19 clones, and Syn. H 21 clones.

4. Other Varietal Yield Trials are conducted at Ithaca and at several other locations in the state under Plant Breeding State Project 9.

C. Orchard Grass

1. 1949 Polycross Progeny Tests. Of the 284 clones from the Pasture Laboratory, State College, Pennsylvania that were included in the 1947 Polycross Seed Production Nursery, the polycross seed of 108 was planted in a replicated plot test on West Lankin field, Ithaca and at State College, Pennsylvania. The planting at Ithaca seems to have been a failure because of the very dry year. This is most unfortunate as much valuable information on the regional adaptation of these clones as measured by their polycross progenies was expected from this test. If the stands in the spring of 1950 are found to be too poor for a yield trial, an effort will be made to replant this test.

2. 1949 Isolation Plots of Two Synthetics. These were established with good stands in the summer of 1949. The early synthetic is composed of six clones and the late synthetic of seven clones selected on the basis of their clonal performance in the 1947 Polycross Seed Production Nursery.

3. Varietal Yield Trials are conducted at Ithaca and Churchville, New York under Plant Breeding State Project 9.

D. 1949 Maintenance Nursery

This nursery was started in 1949 on two different tracts on the McGowan field at Ithaca. The purpose of this nursery is to maintain the selected plants vegetatively in order to have them available at any time while they are being progeny tested. At the present time the following selected clones are being maintained in the various species and most of them are in this special nursery:

1. Alfalfa	C-clones	93
	New York clones	301
2. Bromegrass	New York clones	495
	Pasture Laboratory clones	27
3. Orchard grass	New York clones	54
	Pasture Laboratory clones	256
4. Timothy	New York clones	172
5. Reed Canary grass	New York clones	136

6. Tall Oatgrass	New York clones	363
7. Meadow Foxtail	New York clones	50
8. Red Fescue	New York clones	46

Title: Breeding and Cytogenetic Investigations with the Forage Plants of New York (B-J Pl. Breed. 76.).

Leaders: R. P. Murphy, S. S. Atwood, C. N. Hittle, E. D. Donnelly, C. C. Lowe, and R. D. Ensign

Report: (This report covers the fiscal year 1949-50 and duplicates some of the material described in last year's Report).

The breeding and cytogenetic studies made in 1949 are described here separately for each species.

A. Alfalfa

1. 1946 Clonal and Source Nursery. No further notes on the materials in this nursery were taken and it has been discarded. The 92 plants selected from this nursery were maintained and 84 finally established in a clonal evaluation nursery in 1949.

2. 1947 Clonal and Source Nursery. Notes were taken on vigor and disease and insect reaction in 1949. A total of 98 plants of clones and seedlings were selected for use in the breeding program. Most of these will be established in a clonal evaluation nursery in 1950. The remainder of this nursery was plowed in the fall of 1949.

3. 1948 Clonal Nurseries I and II. Of 346 clones that were established in this nursery, 143 were selected for progeny testing; the polycross seed, harvested from the first crop in 1949 will be used for this test. Extensive notes were taken on the performance of these clones in this nursery. Of this group to be progeny tested under R & M Plant Breeding Project 26-1, 9b1 and 9b2, 65 are C-clones (National Alfalfa Conference clones) and 78 are clones selected in New York. Of the group from New York 49 were selected for the regional testing in the Northeast of new breeding materials under objective 2 of R & M Project NE-10, 9b3.

4. 1949 Clonal Nursery. A new clonal nursery was established with 148 clones. This group originated as follows: 84 from 1946 clonal and source nursery, 38 from 1945 clonal and source nursery and 26 check clones (primarily C-clones now used in experimental synthetic varieties and single crosses). The establishment of these clones was fair to good and some notes were taken in the fall.

5. 1949 Single Cross and Inbred Progeny Nurseries. The single crosses, 75 in total, which were produced in the greenhouse in 1948-49 for all combinations within six different groups of clones, were established in six replications of spaced 10-plant rows at two different locations in 1949 along with eight check varieties and

cuttings of the 17 parental clones. The seed obtained from selfing clones was also established in a similar manner at one location. Seedlings from the extra seed of these single crosses and inbred progenies were inoculated with the bacterial wilt organism and transplanted to the field as a source nursery. Seventeen of the best clones, as measured by their performance in New York, were crossed to a highly wilt resistant clone from California and these progenies were transplanted to the field as spaced plants in 1949. From 12 of the progenies five seedlings were selected and backcrossed to both parents in order to obtain information on the inheritance of wilt reaction and to obtain desirable wilt resistant clones. This phase of the research on inheritance of wilt reaction is part of a thesis of Mr. E. D. Donnelly, supported in part by U.S.D.A. funds.

6. Genetic Studies. These studies are being continued with such characters as white flower, male sterility, red root and odd leaf.

7. 1949-1950 Greenhouse Breeding Studies: Five clones, most desirable as measured in New York, were crossed to several different clones for the purpose of adding specific characteristics to these clones. These materials included were three rhizomatous clones found in old fields in New York, four creeping-rooted clones from the Swift Current, Saskatchewan, Canada, experiment station, two fibrous-rooted clones isolated in New York from an introduction from Turkey by Westover, two fibrous-rooted clones of Medicago falcata isolated in New York from introductions and one fibrous-rooted clones of M. gaetula isolated in New York from an introduction.

8. 1946, 1947, 1948 and 1949 Uniform Observation Nurseries. Yields were obtained from all these row nurseries except the one planted in 1949 which will be harvested in 1950 for the first time. Highly significant differences in yielding ability were obtained in all of these; such information is useful for the preliminary evaluation of new clones as they come into the National Cooperative Alfalfa Breeding Program.

9. Cytological Studies. The work conducted by Dr. Grunn has been completed for publication, and no further studies are being carried on at present.

10. Wilt and Insect Tests. Limited tests on breeding materials for their reaction to wilt were continued but inconclusive results were obtained. Because of inadequate greenhouse space some of this work will be done in the field hereafter. The "screening" of the Ontario Variegated variety of alfalfa for wilt resistance was started in 1949 and the progeny of the first cycle was being continued. Further observations on the insect reaction of a number of clones are being made by Prof. G. G. Gyrisco of the Department of Entomology.

The reports given under this project in previous years for Advanced Uniform Nurseries (plots), 1948 Nursery of Eastern, Northern, and Rhizomatous Synthetics, 1948 Ranger Increase Study and 1948 New York Polycross Progeny Test will be given under R & M Plant Breeding Project 26-1, 9b1 and 9b2.

B. Red Clover

Seed was harvested from plants that survived in the second harvest year from the 1947 variety yield trials (plots). This seed will be used for source material in the future. No notes on disease reaction were taken in 1949 as no differential reactions among the varieties was noted in this very dry and warm growing season.

C. Ladino clover

Further notes were taken on the replicated 10-plant spaced rows from each of the polycross seed progenies of 20 clones from the Idaho foundation planting, from six imported lots and from certified Oregon seed. No differences in winterkilling have been observed; the plants will be re-examined in 1950.

D. Zigzag Clover

The ten clones which were transplanted to the Pulleyn field have made a very poor growth and establishment. It will probably be necessary to reestablish these in another planting.

E. Bromegrass

1. 1948 Polycross Seed Production Nursery. The 234 I_1 plants and 36 check plants that were planted in ten replications of spaced individual plants made poor growth in 1949. Notes on vigor and disease reaction were taken, and it is planned to harvest polycross seed from the best clones in 1950.

2. 1948 Inbred Nursery. This nursery consists of replicated spaced 10-plant rows of I_1 and I_2 progenies of selected plants. Since no progenies were equal to the check rows, this planting will be used only as a source nursery for superior clones.

3. 1948 Source Nursery of Single Crosses. Notes on this material indicated the presence of some outstanding plants and progenies. Some of these will be selected in 1950 for further study.

4. 1947 Polycross Seed Production Nurseries I and II. Seed for polycross progeny testing purposes was harvested from both of these nurseries as follows: 54 out of 240 clones from New York and 26 out of 173 clones from the Pasture Laboratory at State College, Pennsylvania.

5. 1948 Breeding Studies. A special study on the variation in seed set among 30 clones was continued by Mr. C. C. Lowe, a graduate assistant, and the results of this test will be written up in a master's thesis in 1950. A special study designed to measure the variation in performance among the progeny from ten open-pollinated heads selected at random from each of 20 clones in the 1946 polycross seed production nursery, together with progeny from the bulked polycross seed and the cuttings of the parent clones, is being continued by Mr. C. N. Hittle, a graduate assistant. The results of these studies will be of considerable value to the breeding program.

F. Orchard Grass

1. 1947 Polycross Seed Production Nursery. Seed for polycross progeny testing purposes was harvested from 108 of 284 clones which were obtained from the Pasture Laboratory, State College, Pennsylvania. A study by Mr. H. Oropeza, a graduate student, on the variation among the selected group of clones in their self- and cross-fertility was started in 1949, and will be presented as a master's thesis this spring.

2. 1949 Polycross Seed Production Nursery. Good establishment was obtained in this nursery, started in 1949, using clones from the following origins: 114 from the Pasture Laboratory, State College, Pennsylvania, 13 from Minnesota, 13 checks from 1947 Polycross Seed Production Nursery and 20 from New York.

G. Timothy

1. 1948 Polycross Seed Production Nursery. Notes on vigor and disease reaction were taken in 1949, and polycross seed was harvested from 56 clones selected out of the original group of 240. Several promising clones of late maturity were noted.

H. Reed Canary Grass

1. 1948 Polycross Seed Production Nursery. Notes on vigor were taken in 1949, and polycross seed was harvested from 84 clones selected out of the original group of 150.

I. Tall Oatgrass

1. 1949 Polycross Seed Production Nursery. 240 clones were established as spaced individual plants in ten replications. Good establishment was obtained and these will be studied in 1950.

2. 1947 "Awnless" Selections. The best individual plants were selected from this planting for further use in the breeding program. None were completely awnless but many plants had very reduced awns.

J. Source Nurseries of Timothy, Reed Canary Grass, Tall Oatgrass, Meadow Fescue, and Tall Fescue at Tully.

Selected plants of Reed Canary grass and tall oatgrass were moved to Ithaca in 1949 and these source nurseries were plowed. No plants were selected from the fescue nurseries and no further breeding work is planned with these fescues at this time.

K. 1947 Technic Study and Polycross Progeny Test. Yields were taken in 1949, and this planting was plowed in the fall. The data have not been summarized completely as yet.

L. Aftermath Study

No further experiments were planned in 1949. It is planned to complete this summary and publish the results in the near future.

Title: Strain Testing and Breeding of Forage Plants for New York State and Vicinity with Special Emphasis on Problems of Production During Periods of Midsummer Drought. (Pl. Breed. State Project 9)

Leaders: R. P. Murphy, H. A. MacDonald (Agronomy), S. S. Atwood, A. A. Johnson, C. N. Hittle, C. C. Lowe and R. D. Ensign.

Report: (This report covers the fiscal year 1949-50 and duplicates some of the material described in last year's Report).

A critical evaluation of perennial forage crops varieties depends on the results from a large number of tests made in different locations for a period of years. The results for any one year are important as they contribute to the conclusions. A summary of the results of the strain and variety testing for each species included is given in the following statement.

During the past four years, extensive tests have been made of a wide range of forage crops varieties and strains. These varieties and strains have included: (1) commercial varieties now in use, (2) new varieties not yet released, and (3) local ecotypes developed through natural selection; and these have been tested against commercial lots commonly available. These tests have been located at Ithaca, Churchville (Monroe County), and Tully (Onondaga County) for the most part, and in farmers' fields in four counties. Different fertility levels and management treatments have been tried wherever possible.

Considerable use has been made of the data obtained. The results have been the basis for the variety recommendations for forage crops.

Alfalfa. Of the varieties that are now available, Ranger seems to be the most persistent and is average in yield. It does not do well on sites where alfalfa is not well adapted. For short-time stands, Atlantic seems to be outstanding and the varieties of the northern variegated type are good. Of the varieties which have not been released, Narragansett is outstanding in yield and stand in all places tested. However, these tests have been for only two harvest years.

Red, Mammoth, and Alsike Clover. The new varieties, Kenland and Cumberland, seem to be equal to the best commercial sources and individual farmer seed lots and superior to average commercial seed. Common Oregon lots of red clover and Altaswede mammoth type have been inferior in yield and disease resistance to the better varieties of medium red clover. None of the New York farmer lots has been of sufficient promise to warrant increase. Other sorts of red clover which have been good include: (1) VanFossen strain of Ohio, (2) Ottawa selection, and (3) Dollard. Commercial seed of Alsike produced in Ohio has been superior to western sources.

Bromegrass. As an average of all tests, the "southern-type" varieties Achenbach, Elsberry, Fischer, and Lincoln seem to show no differences in performance that are of practical value, except that Fischer may be slightly higher in yield than the others. When grown with a good stand of alfalfa, the total yield (brome + alfalfa) of all varieties tested is usually similar. However,

as the stand of alfalfa becomes reduced the "southern types" yield more total forage (mostly brome + some alfalfa). There has been no indication of differences among the varieties of bromegrass for the ability of alfalfa to persist with them.

Orchard grass. The variety which seems to have the most promise is Brage, developed in Sweden. It is high in yield and six to seven days later in maturity than commercial types. The varieties developed in Wales have shown some winter-killing, are late in maturity, and have been low in yield in these tests. The sources of seed from Australia and New Zealand have been completely unsuited in this area because of winter-killing and subsequent poor stands and low yields. Of the varieties developed in Canada, Avon, Hercules, and Oron, none has shown much promise in these tests. The question of the desirability of increasing and releasing Brage will depend upon its performance in relation to the several experimental synthetics developed at the U. S. Regional Pasture Research Laboratory. Yield trials to measure their performance have been established or will be in 1950.

Meadow and Tall Fescue. The varieties of tall fescue (Alta, Kentucky 31 and Suiter's) have not been different among themselves in performance in tests to date and as a group have been superior to meadow fescue sorts tested. These species seem to have a very limited use in New York.

Timothy. There seem to be little, if any, consistent differences of practical importance among the varieties for yield. The fact that varieties are available which differ in time of maturity by as much as two weeks seems of importance. The use of varieties of different maturity by an individual farmer would spread the harvest season for him and a later variety should have a place in combination with Empire Birdsfoot trefoil, a late variety, on cold, poorly drained soils and at high elevations. Varieties which are considered to be of value in the various maturity groups might be classified as follows: (a) early - Milton, (b) mid-season - Lorain and Climax, (c) late - Medon and Drummond.

Reed Canary grass. Ioreed seems to be as good as any varieties and farmer lots tested. Superior, from Oregon, has winterkilled almost completely in all tests.

Tall Oatgrass. Tualatin, from Oregon, has been about equal to commercial lots in yield and is about three days later in maturity. This variety seems to be the best material for increase as it shatters less than others and, thus, is more suitable for seed production.

Other Species. No further data on Ladino clover, sudan grass, and Birdsfoot trefoil were obtained in 1949-50, but tests were established in 1949 for Ladino and trefoil and will be harvested in 1950-51.

Title: Some Factors Affecting the Seedling Establishment of Forage Legumes

Leaders: H. A. MacDonald and W. A. Williams

Progress: Seedling emergence and early vigor were found to be favored by mulching with straw, manure, or other material. Soil crusting, maximum soil temperatures and moisture loss were reduced by this techniquo.

The most favorable spring seeding date for forage legumes was found to be at or just following the date of first vegetative growth. Earlier dates of seeding were in general less satisfactory.

In seed and fertilizer placement studies using radioactive phosphorus, it was found that the seedling in the early stages of growth is dependent upon nutrients in close proximity to the planted seed or directly below it. Little early value was obtained from fertilizer far removed from the seed.

Studies at several locations and on several soil types demonstrated the importance of eliminating the original vegetation in pasture renovation. In all cases, as the amount and strength of the original vegetation were reduced, seedling establishment increased. Where possible, a well prepared seed bed gave the best results.

Competition studies involving a companion crop have given inconclusive results. Where nutrients and moisture were adequate and lodging was not a factor, no serious affects have been noted at normal seeding rates.

Title: Studies of Birdsfoot Trefoil as a Forage Legume in New York

Leader: H. A. MacDonald

The work of this project was continued during 1950 with special emphasis being given to seedling establishment, management, seed production and the evaluation and improvement of varieties for hay and pasture.

In comparative trials satisfactory seedling establishment was obtained only where adequate moisture, mineral nutrients, and nitrogen or inoculation were satisfactorily provided. Establishment and early seedling growth was retarded by excessive competition by grasses or other legumes. Relatively slow germination and seedling development results in Birdsfoot trefoil being somewhat more susceptible to seedling hazards than alfalfa or red clover. Recent studies indicate that hard seed occurring in this crop may be of little value.

The European sources of Birdsfoot trefoil have performed better under meadow than under pasture management. The Empire variety (New York broadleaf), and others similar in type, perform well as both hay and pasture. These are somewhat slower in rate of development. Summer killing caused by Rhizoctonia root and crown rot has been most severe where lodging of the crop is excessive and prolonged. Little killing occurred under grazing.

Selected strains are being increased for further trial.

Title: The Effect of Stage of Growth upon the Yield, Nutritional Value and Longevity of the Principal Forage Grasses and Legumes

Leader: H. A. MacDonald

Progress: The most active phases of this project during the past year concerned the influence of management upon plant survival and the influence of growth stage upon the micronutrient composition.

With both grasses and legumes the influence of crop management upon insects and plant disease was found to be of major importance, in many cases more important than the effect of depleted root reserves on plant survival. This influence was most marked in the case of the legumes studied.

Timothy was found to have a lower content of copper, iron and cobalt than alfalfa, Birdsfoot trefoil or Ladino white clover. In all species the iron content increased as the plant matured. The major increase occurred in the leaves. The copper content of timothy decreased with advancing maturity while in the case of the legumes it reached a peak about the bloom stage, then declined. There was a slight increase in the cobalt content toward maturity. This was not significant in the legumes, however. The manganese content increased slightly toward maturity, but was significant only in timothy and the stems of Birdsfoot trefoil and the petals of Ladino clover.

Title: The Effect of Seeding Rates, Fertilizer Application, and Management in Forage Mixtures on the Survival and Productivity of Alfalfa under Various New York Environments

Leaders: W. K. Kennedy, R. Bradfield, and H. Fribourg

Progress: Yield and stand count of alfalfa seeded alone and with red clover, Ladino clover, and timothy were obtained in 1950. Though the yields during the first harvest year were not influenced by the seeding mixture, the number of alfalfa plants per unit area and the percentage of alfalfa were affected by the rate of seeding and seeding mixture. Differential fertility treatments and intensity of cuttings have not resulted in any differences to date.

The effect of fertilizer placement on the establishment of alfalfa and smooth bromegrass was studied in 1950. Superphosphate, lime and superphosphate, complete fertilizer, and lime and complete fertilizer were drilled to a depth of 1-1/2 inches in comparison with broadcast application of the same fertilizer which was mixed with the top 2 inches of soil. The forage crop seeds were drilled 1/2 inch deep directly over the row of fertilizer. Superphosphate, and lime and superphosphate drilled below the seed resulted in greater seedling vigor than any of the broadcast applications. Drilling a complete fertilizer slightly depressed seedling vigor compared with broadcast applications. Six weeks after seeding no differences between treatments were evident.

Title: The Effect of Feeding Dairy Cows Certain Fungicides Used to Prevent Mold Growth in Hay on the Production and Quality of Milk

Leaders: Agronomy: W. K. Kennedy and R. Bradfield
Animal Husbandry: J. Thomas Reid, George Trimberger, and K. S. Turk

Progress: In January, 1950, two fungicides, 2-4-6 trichlorophenol and ortho-phenylphenol were applied to moist alfalfa hay at the rate of 10 pounds per ton. Mold growth was prevented by the 2-4-6 trichlorophenol but not by orthe-phenylphenol. Dairy cows objected to the treated hay and would not eat the roughage. When the treated hay was mixed with equal parts of untreated hay the cows ate limited quantities during the first week to 10 days and gradually increased their intake to normal levels. The dilution of treated hay with untreated hay was gradually reduced until only treated hay was being fed. Though off-flavor in the milk could not be detected consistantly, the milk of all cows receiving treated hay was graded as having a medicinal taste at least once during the experiment. Further trials with hay treated with 2-4-6 trichlorophenol in August are being conducted at the present time. The hay is of good quality and the daily intakes are high. To date no off-flavor of milk has been detected. Dry cows are being fed also to determine if the fungicide is accumulated in the body fat and then released into the milk when the cow freshens.

Title: The Relationship of Milk Production to Herbage Characteristics from Permanent and Rotation Pasture Mixtures

Leaders: Animal Husbandry: J. Thomas Reid, George Trimberger, and K. S. Turk
Agronomy: W. K. Kennedy, H. A. MacDonald, and R. Bradfield

Progress: The treatments were the same as those reported in 1949. Again the yield of milk and dry matter was highest for the bromegrass-Ladino clover-alfalfa mixture and lowest for the permanent pasture. In the first 42 days of the grazing season (May 14 to June 25) the cows received no supplemental feed and obtained about 25 pounds of T.D.N. per cow per day. After June 25 the production of pastures declined and the cows were able to obtain about 14.5 pounds of T.D.N. per cow per day from the seeded pastures and less than 9 pounds of T.D.N. per cow per day from the permanent pastures. During this period the cows grazing the seeded pastures produced 6 to 8 pounds more of 4 percent fat-corrected milk, gained more weight and received 3 to 5 pounds less grain per day than the cows on the permanent pastures.

Title: Factors Which Influence the Longevity, Seasonal Growth and Productivity of Ladino Clover

Leaders: W. K. Kennedy, E. M. Kroth, and R. E. Sigafus

Progress: The effect of type and intensity of cutting and fertilization of Ladino clover on the food reserves and winter hardiness was studied. In general the results were similar to those reported by other workers. Frequent or late cutting of Ladino resulted in lower food reserves and greater winter killing. Heavy fertilization with potash resulted in increased yield and higher starch content in stolons harvested in November. The starch content of the stolons and roots of two hardy and two unhardy clones were compared. Results indicate there is considerable variation in the starch content of different clones and raise a question whether such a measurement could be used for estimating winter hardiness.

Title: Alfalfa Snout Beetle Investigations

Leaders: George G. Gyrisco, D. S. Marshall, and C. E. Palm

During 1950, several chlorinated hydrocarbon and organophosphorus insecticides were tested in several experiments as 1 per cent dusts, sprays and thermal aerosols for the control of the alfalfa snout beetle. In addition in 2 experiments, aldrin, dieldrin and chlordane were substituted at 2 different concentrations for sodium fluosilicate in the standard snout beetle bait.

One percent impregnated dieldrin and aldrin dust when applied at the rate of 100 pounds of dust per acre controlled more than 95 percent of the alfalfa snout beetles in two weeks and were the best materials tested for that purpose.

Dieldrin, aldrin, lindane, chlordane and benzene hexachloride were all effective for controlling the snout beetle as a 1 percent spray applied with a weed-killer type, low pressure sprayer at the rate of approximately 40 gallons per acre.

Thermal aerosols made from 1 percent oil solutions of aldrin, dieldrin, benzene hexachloride and lindane applied during unfavorable weather conditions with a standard thermal aerosol applicator were effective for a distance of 10 feet from the nozzle in controlling the snout beetle. Toxaphene was inferior in its action to the other insecticides mentioned.

One and 2 pounds of aldrin, dieldrin, and chlordane were found to be superior to 8 pounds of sodium fluosilicate in the standard snout beetle bait. The chlorinated hydrocarbon baits gave better immediate and residual kills of alfalfa snout beetles.

Title: Spittlebug Studies

Leaders: George G. Gyrisco and D. S. Marshall

Seventeen field experiments using 11 chlorinated hydrocarbon and organophosphorous insecticides as dusts and sprays at several levels of concentration for the control of the meadow spittlebug were conducted

in 1950. All the sprays were applied with a low pressure, weed-killer type sprayer, using 30-40 pounds pressure and applying 20-40 gallons of spray per acre. The dusts were applied with a power forage duster or with a hand fertilizer spreader.

Sprays were found to be at least twice as effective as dusts for the control of the meadow spittlebug, at the same concentration of insecticide per acre. Of all the materials tested, benzene hexachloride was found to be the best insecticide for spittlebug control although dieldrin was also outstanding for that use.

Although excellent control of first and second instar nymphs of the spittlebug was obtained with as little as 0.05 pounds of gamma isomer of benzene hexachloride per acre when this insecticide was applied as a spray, it was found that at least 0.3 pound of gamma isomer of benzene hexachloride or dieldrin applied as a spray was needed for practical control of all instars of the meadow spittlebug.

Title: White Grub Investigations

Leaders: R. H. Burrage and George G. Gyrisco

Brood A June beetles which are found in Catteragus, Jefferson, and Wyoming Counties of New York were in flight during 1950. Although light traps were maintained in these areas from May to August, very few adult beetles were taken as the infestation was very light. Diggings made in the Brood A area failed to reveal any heavy new infestations of new grubs.

Ecological studies in which soil temperature, moisture and pH were correlated with grub distribution were continued in Chautauqua, Erie, Essex, Jefferson, Oswego and Wayne Counties.

Insecticide tests using aldrin, dieldrin, lindane, benzene hexachloride, parathion, chlordane and lead arsenate at several levels of concentration for the control of white grubs on strawberries were conducted in Chautauqua, Erie, and Oswego Counties. Unfortunately good trials were not secured because the infestations of grubs failed to materialize. However, berries from plots treated with 12 pounds of actual parathion and chlordane per acre, 4 pounds of actual dieldrin aldrin and gamma isomer of benzene hexachloride per acre and 250 pounds of lead arsenate per acre, tasted fresh and cooked gave no off-flavor or odor. Berries from all these plots were also canned and jamned for further tasting.

Title: European Chafer Studies

Leaders: R. H. Burrage and George G. Gyrisco

Investigations of the control of the grubs of the European Chafer in 1950 by means of insecticides, included the use of DDT, chlordane, dieldrin, aldrin, benzene hexachloride, lindane, parathion and heptachlor. All these materials except DDT were applied as sprays

and dusts at rates from 1 pound to 8 pounds of actual toxicant per acre. DDT was applied in a similar manner at rates from 2.5 pounds to 50 pounds of actual active ingredients per acre. All the dusts were applied with a power duster or a hand fertilizer spreader while the sprays were applied as emulsions from a weed-killer type low pressure sprayer. Both methods of application were highly successful. Sprays appeared to penetrate the soil better and kill the grubs much sooner than did the dusts.

Insecticide treatments were applied at three different times of the year: in the spring, just before the first beetle flight, and in the fall. Summer and fall treatments were superior to spring treatments. This was probably because the nymphs were smaller and easier to kill at this time.

Dieldrin, aldrin, benzene hexachloride and parathion when used as dusts at the rate 2.5 pounds of active ingredients per acre gave good control of the grubs 60 days after application in the fall. Chlordane was significantly inferior to these materials.

Heptachlor and aldrin when applied as emulsions in the fall at 2.0 pounds per acre completely eradicated the larval population. Dieldrin, when used at 2.5 pounds per acre in a similar manner, just previous to beetle flight also completely killed the larvae of the new chafer brood.

DDT as a spray was highly effective at the rate of 5 pounds per acre, but 10 pounds per acre seemed better. Here again, sprays appeared to be more effective and speedier than dusts.

Title: Resistance of Alfalfa to Insects

Leaders: George G. Gyrisco, S. S. Atwood, D. S. Marshall and R. P. Murphy

Further studies were continued in 1950 in cooperation with the Department of Plant Breeding on the resistance of selected breeding clones of alfalfa to the potato leafhopper.

In a method described in an earlier report, 124 clones were tested in 1950 for resistance to the potato leafhopper. Several of the clones showed promise for resistance to potato leafhopper attack and will warrant further testing. Among these were clones coded as: C-8, C-12, C-36, C-53, C-87, C-188, D-6, 3-80, 4-26 and 4-94. Some of the more susceptible clones were: C-59, C-195, M-38, S-7, 1-6 and 1-63.

Pennsylvania Agricultural Experiment Station

Title: Variety Trials of miscellaneous grasses

Leaders: H. R. Fortmann and H. L. Carnahan

Table 21. - Average 1950 yields (tons dry matter per acre) of varieties of meadow fescue, tall oatgrass and perennial ryegrass at 5 locations with 4 replications per location (Seeded alone).

Variety	First Cut	Second Cut	Season Total
	Meadow Fescue		
Suiter's Grass	1.79	0.96	2.70
Mefon	1.78	0.77	2.55

Commercial	1.82	0.81	2.63
Alta	1.64	0.93	2.60
Kentucky 31	1.88	0.95	2.83
S-53	1.50	0.87	2.38
S-215	1.61	0.80	2.42
Average	1.72	0.87	2.59
Tall Oatgrass			
Tualatin*	2.03	1.50	3.53
S.C.S. Non-shattering	1.85	1.39	3.20
Commercial	1.70	1.45	3.14
Average	1.86	1.45	3.29
Perennial Ryegrass			
Peron	1.30	0.67	1.98
S-23	0.97	0.83	1.79
S-24	1.25	0.75	2.01
S-101	1.22	0.77	1.99
Average	1.18	0.75	1.94

*4 locations only.

Title: Evaluating Various Tall Growing Grasses with Different Legumes and with Nitrogen Fertilizer for Pennsylvania

Leaders: J. B. Washko and R. P. Pennington

The following grasses are being evaluated with Ladino clover, alfalfa, and Birdsfoot trefoil at five locations in the state: smooth bromegrass, orchard grass, timothy, Reed Canary grass, and tall oatgrass. In addition to the five already mentioned meadow fescue and tall meadow fescue are also being evaluated with 100 pounds per acre of nitrogen applied in two 50 pound applications; (1) early spring, (2) after the first harvest. The five highest yielding combinations averaging all locations for two cuttings in 1950 were in the order mentioned; Ladino-bromegrass, tall oatgrass with N, alfalfa-bromegrass, orchard grass with N, and bromegrass with N.

Title: Forage and Grain Production of Winter Small Grains as Influenced by Fertilization and Management Practices

Leaders: J. B. Washko, R. P. Pennington and A. L. Haskins

Investigations were initiated in 1949 to determine (1) the value of winter small grain as dual purpose crops, i.e. for forage and grain, (2) whether forage removal can be compensated for and grain yield reduction minimized by high nitrogen fertilization, (3) the degree to which seeding rate, time of seeding and method of seeding influence forage production, and (4) the nutritive value of the forage as determined by

chemical analyses. Accordingly, experiments were established at two locations in the State with different soil and climatic conditions, Southeastern and Central Pennsylvania respectively. The factors studied in these experiments were: two seeding dates, two varieties of winter wheat and two of winter barley, four nitrogen treatments and two clipping treatments which simulated grazing.

The first year's results indicate that heavy fertilization particularly with nitrogen, time of seeding and periods of forage removal are highly important if winter small grains are to be used for both forage and grain production.

As regards nitrogen applications it was found that 80 pounds of N per acre not only gave higher yields of forage but herbage with a higher protein content than where only 40 pounds of N per acre were used. In addition the heavier nitrogen applications minimized grain yield reduction due to forage removal.

If fall forage production is desired early seeding of the small grains is essential. No fall herbage removal was possible when the small grains were seeded at the recommended planting date. When seeded August 15, which is five weeks earlier than the recommended seeding date, it was possible to remove two fall forage harvests. Spring forage production was favored by the date of seeding normally recommended for small grains when compared with early seeding and fall forage removal. In no case, however, were the spring forage yields equal to those obtained in the fall.

As would be expected, forage removal influenced grain yields. Clipping both in the fall and in the spring was more deleterious to grain production than either fall or spring clipping alone. In regard to their effects on grain production, spring clipping alone was intermediate and fall clipping alone was least harmful. Fall clipping in several instances stimulated grain production in that greater yields of grain were obtained than from the unclipped seedings. However, even in those instances where forage removal was followed by grain reduction, if the combined forage and grain yields are expressed in terms of total digestible nutrients removed per acre, such forage removal was beneficial rather than detrimental. In several of the treatments the yields per acre of total digestible nutrients for forage and grain combined were more than twice as great as for grain production alone.

Results from these investigations also indicate that winter barley may have greater potentialities than wheat for dual purpose use since the two barley varieties outyielded the wheat varieties in both forage and grain. Location effect, probably the longer growing season, was expressed primarily in greater forage yields from Southeastern than from Central Pennsylvania.

Title: Effects of Different Stubble Management Practices on Maintenance of Red Clover and Timothy

Leader: J. B. Washko

Wheat straw and stubble in which a stand of red clover and timothy had been established the previous spring (1949) was handled after combining

as follows: (1) straw left on, (2) straw scattered but left on, (3) straw removed, (4) straw removed, stubble clipped and left on, (5) straw removed, stubble clipped and removed, (6) straw removed, stubble clipped and removed, and a 0-10-10 fertilizer applied at the rate of 500 pounds per acre. Across the plots the following treatments were superimposed; no mowing, mowing August 15, September 1 and October 1. All stubble and clover were removed following mowing. The results were measured in terms of hay yields and clover populations.

As regards straw and stubble management, leaving the straw on the plots was detrimental to hay yields. Straw removal followed by clipping and removal of stubble was conducive to best hay yields. Stubble cuttings on August 15 and September 1, 1949, were best for red clover survival in 1950. Non clipping of stubble or clipping as late as October 1, 1949 were detrimental to maintenance of red clover but more favorable for timothy maintenance. Hay yields were not adversely affected by the non-mowing and October 1 clipping, however, since the timothy made up for the loss of red clover. Hay quality, however, was influenced since there was less clover in the hay where no clipping and October 1 clipping were practiced.

Title: Establishment and Maintenance of High Quality Pasture Mixtures on Unproductive Lands

Leaders: R. P. Pennington and J. B. Washko

In this experiment legume-grass combinations were seeded at different levels of mineral fertility at five locations in the state.

At State College (Centre County) and at Graterford (Montgomery County) one replication involving alfalfa, Birdsfoot trefoil and Ladino clover in combination with bromegrass, orchard grass, tall fescue, tall oatgrass, timothy and Reed canary grass was seeded. The fertility levels were 40, 80, and 120 lbs. of added phosphorous per acre, 0 and 100 lbs. of added potassium per acre and one-half and full lime requirement on the Ladino and Birdsfoot trefoil. With alfalfa, the full lime requirement was reached and two levels of boron used 0 and 40 lbs. of borax per acre. These are laid out in a completely factorial design.

At Somerset (Somerset County) and Wernersville (Berks County) the soil needed little or no lime. The same experiment was started except two replications were seeded with Birdsfoot trefoil and Ladino.

In the northeastern section of the state, at Elk Lake (Susquehanna County) where the soil is very poorly drained alfalfa was not seeded. The fertility and lime levels were not changed. The grasses used with Ladino and Birdsfoot trefoil were: Kentucky bluegrass, perennial ryegrass, orchard grass, tall oatgrass, tall fescue, timothy and Reed canary grass.

Once establishment has been tested the plots will be split and two different maintenance applications made.

All areas in this experiment were seeded in the spring of 1950.

Title: Effect of nitrogen on the establishment of legume grass mixtures at different levels of mineral fertility

Leaders: R. P. Pennington and J. B. Washko

An experiment to test the effect of nitrogen on the establishment of legume-grass mixtures at different levels of mineral fertility was seeded in the spring of 1950 at State College.

The legumes used were alfalfa, Birdsfoot trefoil and Ladino clover, while the grasses were orchard grass and bromegrass. Three levels of mineral fertility were used - 0, 400 lbs. and 800 lbs. per acre of 0-20-20 fertilizer. The N levels used were 0, 20, 40 and 80 lbs. of nitrogen per acre applied at seeding time.

Each main plot contains the legume and one nitrogen treatment. The six sub-plots are each grass at each level of mineral fertility. This is laid out with four replications in a completely factorial design.

The effect of nitrogen will be studied by yield, botanical composition of the forage, and chemical analysis of the legumes and grasses for nitrogen, potassium and possibly phosphorus.

Title: Trace element survey of Pennsylvania

Leaders: Agronomy Department: R. P. Pennington
Animal Nutrition: C. E. French and R. W. Swift

A survey of the trace element content of plants in relation to soils has been started. The project will involve the collection of plant samples from different well drained soils developed from different plant materials.

The plants used as indicators will be red clover and timothy which will be sampled at full bloom and head stage respectively. Mature oat grain will also be used.

The plant samples will be analyzed for trace elements in order to get an indication of which soils are low in these elements.

Title: Protein Requirements of Pigs on Pasture

Leaders: J. L. Gobble, F. L. Bentley, R. C. Miller

On July 3, 1950, a feeding trial was started with three lots of pigs on orchard grass pasture to determine the value of adding a so-called APF supplement to a plant protein ration. Lot No. 1 was self-fed free choice shelled corn, solvent process soybean oil meal, and a simple mineral mixture. Lot No. 2 was self-fed free choice shelled corn, solvent process soybean oil meal with APF added, and the mineral mixture. Lot No. 3 received self-fed free choice shelled corn, a mixture of one part 60% protein tankage, and one part solvent process soybean oil meal, and the mineral mixture. Lot 3 was included as a check ration.

Table 22. - Results of feeding trials

	No. of Pigs	Ave. Initial Wt.-lbs.	Ave. Final Wt.-lbs.	Ave. Daily Gain-lbs.	Feed Required per Cwt. Gain-lbs.
Lot 1	5	95.0	185.2	0.99	500
Lot 2	5	101.0	214.2	1.22	430
Lot 3	4	97.0	202.3	1.16	410

The data indicate some increase in rate of gain from the APF supplement. As expected, the two sources of protein seem to give a faster gain. The inclusion of APF in the plant protein ration seems to give increased efficiency of feed utilization but apparently not as much as when half of the protein supplement is of animal origin.

Title: Sulfur Dioxide for Preserving Hay-Crop Silages

Leaders: C. B. Knodt and R. S. Skaggs

Based on preliminary work done at Montrose, Pennsylvania in 1949, this project involved the preparation, sampling and analysis of 192 barrels of hay-crop silages and corn silage. Early bloom timothy and red clover, late bloom bromegrass, second cut orchard grass-Ladino clover and second cut alfalfa were used in the tests. Corn silage was also studied.

Batches of each hay-crop material were ensiled in 50 gallon steel barrels. Treatments were: wilting or not, without preservative; addition of corn-and-cob meal, 200 pounds per ton; and treatment of the fresh material with 3, 5 and 7 pounds SO_2 per ton. Samples (one from each barrel) were taken two hours, 1, 3, 7, 14, 30,60 and 120 days following preparation. Samples were frozen and kept in that condition until analyzed.

Chemical studies of these samples show that SO_2 applied at 5 or 7 pounds per ton results in a pH of close to 4.0 within 24 hours; lowering of pH is more rapid when the materials are high in moisture. At these rates, sulfur dioxide destroys mold organisms, keeps normal fermentation at a minimum and preserves the green material in much the same fresh state throughout the storage period. There is little destruction of the

carbohydrates, proteins and carotene which is common in hay-crop silage if it is properly treated with sulfur dioxide when placed in the silo.

Sulfur dioxide treatment appears to be most effective with materials high in moisture or with mixtures containing a large percentage of legumes, that is, where the materials would not be expected to make good quality silage without the addition of some preservative. It is comparatively cheap and easy to apply.

Title: Harvesting and Processing Equipment for Seeds of Certain Grasses and Legumes

Leaders: H. B. Musser, A. W. Clyde, J. E. Nicholas

An experimental scarifier was built and used with a considerable quantity of crown vetch seed. This scarifier has an abrasive wheel 12 inches in diameter and a fan. Seed is fed into a narrow space between the wheel and a rubber stationary member. Different speeds and various spacings between the wheel and the rubber were tried and the effect on germination was determined by germination tests.

Most of the experimental equipment for the seed dryer is stored, including a "glass belt", pending decision as to where it will ultimately be placed.

Preliminary studies on "drying of seed" by infra-red lamps have been made. A new source of infra-red radiation from a "Corning Glass" plate heater will be used.

Title: Handling Chopped Forage

Leaders: R. U. Blasingame, A. W. Clyde, A. S. Mowery

An experimental chain-and-flight elevator was constructed and tested with grass and corn silage to determine whether suitable capacity can be obtained by using an improved chain at higher speed than had been used in the past, and also to determine its power requirements. The results were encouraging as to capacity and the power requirement was much lower than that of a blower. A longer elevator is now being built for test this coming season.

A wagon box suitable for handling chopped forage was built and used. It incorporates some new features, such as plywood sides and bottom, which are being tested for serviceability.

Rhode Island Agricultural Experiment Station

Title: Studies on the Improvement of Pastures in Rhode Island

Leaders: Irene H. Stuckey, B. W. Henderson, Jr.

This project was terminated at the end of the summer 1950 and a bulletin is being prepared from the data. There are some significant

results from the last season. Ladino clover was killed almost 100% by the sudden drop in temperature the last week in February and the first week in March. Recovery by natural reseeding was excellent on the Lincoln bromegrass plot and on the perennial ryegrass plot and reached 7% on the plot containing Canada bromegrass but by 1950 this latter plot had a rather dense sod of bromegrass in comparison with the Lincoln bromegrass. Many of the plants of perennial ryegrass were killed completely also but enough remained viable for a fairly good stand by the end of the summer. There was almost no recovery of Ladino clover on the Reed Canary grass plot.

The yields for the season were better than those from the two previous years when drought was acute but not so good as the peak yields when the percentages of Ladino clover were higher. It was interesting to find that the percentages of alfalfa were maintained in the Reed Canary grass and that the percentages of alfalfa on the perennial ryegrass plot had increased, in spite of being grazed for five years.

Title: The Value of Good Ranges during Rearing as Measured by Laying House Performance of Pullets

Leaders: William Wiley, Ireno H. Stuckey, Stanley Smith

Rhode Island Red pullets were put on the experimental poultry ranges for the first time during the summer of 1950. The birds were out from June 21 until they were ready for the laying houses September 15.

Four treatments were used:
1. Limed, fertilized, disked and seeded to Ladino clover
2. Limed, fertilized, disked and seeded to Kentucky bluegrass
3. Untreated control
4. Sunporches on which the birds were reared on wire mesh

Because of drought the previous summer, the stands were not so uniform as desired and enough Ladino clover and bluegrass seed had washed from one plot to another that there were no real differences between these plots. Both of these treatments were definitely superior to the untreated controls on which the principal vegetation was hair fescue, daisies and cinquefoil.

Fifty birds were used on each plot which was 46 x 140 feet and each treatment was replicated three times. The stocking rate is equivalent to 350 birds per acre. The mash and scratch feed was the same for all treatments. The pullets were weighed every two weeks during the summer until the last weighing which was three weeks. By the time the birds were put into the laying houses, the pullets reared on sunporches were somewhat heavier than any of the range birds and there was a trend in favor of the birds from the limed, fertilized and seeded plots in comparison with the untreated controls. But too many of the birds moved from one plot to another during the summer to make any differences significant. The birds on the bluegrass and Ladino clover plots seemed to have more vigor and more gloss to the plumage than either of the control treatments but these factors could not be measured. All of the range birds were less nervous than the platform birds. Differences in performance of the birds in the laying houses cannot be evaluated until spring.

Vermont Agricultural Experiment Station

Title: Cytogenetics and Breeding Investigations with Forage Legumes

Leader: A. Gershoy

Trifolium repens var. giganteum 8x = 64. Polyploid Ladino clover. In 1950, first year observations were made from mid-June to mid-October on spaced plants in family lines derived from superior parents in polycross nurseries 4 and 5, and in replicate family line plantings from best parents grown in the 2nd and 3rd polycross fields. A definitive selection of approximately 100 superior plants observed since 1946 with winter hardiness for at least one winter, and vigorous recovery from drouth and leafhopper injury will have been made in the spring of 1951. Selection of superior plants and of seedlings has been made primarily in superior maternal lines. An extensively replicated, randomized planting of these selections will be made in 1951 in isolation. Seeds will be gathered in bulk for seed increase. Eventually, yield and persistence trials will be made, on a regional basis, in solid plantings in plots and under farm conditions. In preliminary, small scale, solid plantings the growth habit of polyploid Ladino in grass association and alone differs appreciably from that in solid plantings of standard commercial Ladino. The polyploids tend to grow as more compact and less spreading plants whose height tends to keep pace with associated (orchard) grass. The larger size and greater weight of the 8x seed necessitates a suitable adjustment of the seeding ratio as compared with that of commercial sources. Thorough scarification is necessary to obtain a good stand in the seeding year. A new series of primary autotetraploids (C_1) synthesized from native and European seed collections of white clover comprise a comprehensive range in stolon, leaf and flower size. This material will be used in a series of studies of single crosses at the polyploid level.

Lotus corniculatus var. vulgaris. European type broad leaf Birdsfoot trefoil. In 1950, first year observations were made on approximately 1500 spaced, individual plants in family lines raised from superior plants under observation in a 2nd polycross nursery. The material comprises a strain combined from two European and one New York state source. Notations were based on periodic observations throughout the entire growing season. The variation observed between and within family lines related to vigor of growth, rather than differences in botanical type, and selections have been made primarily in the best maternal lines. Progeny selection as well as in best parents will be made in 1951 on the basis of apparent yield, winter hardiness and resistance to drought. Superior plants will be set out in a randomized, replicated planting for the purpose of seed increase. When volume of seed permits agronomic trials will be made, on a regional basis, in solid plantings including farm trials. Preliminary small scale, solid plantings indicate that this strain is quite coarse, is aggressive from seed and is essentially earlier flowering than the New York state Empire type and is characterized by a more determinate flowering habit. In 1950 infection by Sclerotinia trifoliorum appeared quite negligible in the first year of growth of progeny row- and solid plantings.

Lotus tenuis 4x Tetraploid Narrow leaf Birdsfoot trefoil. Progeny lines comprising 1st and 2nd generations, from seeds obtained in open pollinations in clonal nurseries, were under observation in spaced plantings. As was noted in 1949 the larger number of these autotetraploids resembled diploids in botanical type, but differed from the latter in increased size of plant parts and in paucity of seed. However, a small number of individual plants from several maternal lines deviated in botanical type; these were quite leafy, with large, broad leaves and with a compact, erect habit of growth. Some of the plants approached, in type, broad leaf Birdsfoot trefoil. Studies are in progress to determine if these unexpected forms are rogues, unusual combinations at the tetraploid level or field hybrids between L. tenuis 4x and L. corniculatus var. vulgaris. Abundance of pod formation in 1950 on 2 year old plants seemed greater than on the same plants in their first year's growth in 1949. But seed set per pod in the population as a whole did not seem to be appreciably higher, although individual plants appeared to be more fertile. Some plants severely injured in the late fall of 1949 by Sclerotinia trifoliorum recovered to make vigorous growth from rooting branches. In general infection in 1950 appeared negligible when the practice of using interplantings of oats in spaced rows was abandoned. Controlled crosses will be made from superior plants. A small quantity of seed has been harvested for small scale solid plantings. Family line studies are being continued.

Lotus uliginosus 4x. Autotetraploid Swamp trefoil. Seedlings of open pollinated, C_1 parents were under observation in 1950 in their second year of growth in the field. The majority of spaced plants made vigorous growth on light, gravelly loam. Growth was restrained during droughty periods but continued vigorously after adequate rainfall. Seed pods were produced in abundance but comparatively low percentage of seed set per pod paralleled 1949 data. Maternal line selection will be continued. A small amount of seed was harvested for solid plantings to determine winter hardiness from seed. As in 1949 there was no infection by Sclerotinia trifoliorum.

West Virginia Agricultural Experiment Station

Title: Forage Crop Varieties and Species for West Virginia

Leader: O. J. Burger

Because of the failure to obtain stands of the seeding made in August 1949 the entire area was reseeded on April 18, 1950. Good stands were obtained, but a heavy weed infestation necessitated clipping for weed control. Nitrogen, as recommended, was applied after each clipping to the grass-alone plots. Plots were harvested for pasture and hay yields on August 2 and 22, respectively. A second harvest was made on some pasture plots September 15.

The following strains were the highest yielding in their respective species: V - 102 Birdsfoot trefoil, Oregon Certified Ladino clover, Narragansett alfalfa, Midland red clover, S - 26 Aberystwyth orchard grass, Martin bromegrass, and commercial timothy. The above yield performance included all associations.

The highest yielding legume-grass mixtures were Birdsfoot trefoil - bromegrass, Ladino clover- orchard grass, alfalfa - timothy. Red clover yielded more when grown alone.

Where the grass was the basic entity studied, the highest yielding mixtures were orchard grass - Ladino clover, bromegrass-Ladino clover and timothy-red clover.

Kjeldahl determinations are being made and phosphate analyses will be made.

Supplementary Ladino Clover Test

A supplementary Ladino clover test of three strains was seeded April 18, 1950. Two harvests indicate that all three strains yielded more when grown alone than when grown with orchard grass although the differences were not great.

The yield of the 1949 Breeder's Ladino clover and the Oregon Certified Ladino clover was about the same but each vastly outyielded the 1948 Breeder's Ladino clover. Protein and phosphate analyses will be made.

Title: 1950 Bromegrass Synthetic Variety Plot Test

Leader: O. J. Burger

The plots were seeded May 10, 1950, to bromegrass alone and bromegrass-alfalfa. Each was replicated three times for a total of six replications. Yield, stand, color, plant vigor, and percent protein data indicate that synthetic strains A, B, and H are the superior bromegrass strains.

Title: A Study of Some of the Factors Involved in Using Supplemental Irrigation on West Virginia Pastures

Leaders: D. P. Brown and R. E. Emerson, Department of Agricultural Engineering; George Hyatt, Jr., Dairy Department; G. G. Pohlman, S. L. Galpin, and O. J. Burger, Agronomy Department

Because of a plentiful supply of rainfall no supplementary water was needed on either of the bromegrass-Ladino clover-alfalfa or the orchard grass-Ladino clover-alfalfa pastures. Preliminary data on botanical composition were obtained.

Title: Alfalfa Fertility Experiments

Leader: N. H. Baughman

Experiments were initiated in 1948 to investigate the effect of amount and method of placement of fertilizer on alfalfa yields. Plot areas were located on four soil types at four locations in West Virginia. Each area was limed to a pH of 6.5 and received an overall application of 0-10-10 at the rate of 1000 pounds per acre at seeding time. Additional lime and fertilizer were applied on the plow sole and surface on certain plots.

Results: Yields were taken from all plots in two locations for 1949 and three locations in 1950. Data are inconclusive but it appears that of the plow sole applications, only limestone gives significant increases of yields over check. Phosphorus or potash alone gave no significant increases in yield when applied on plow sole, and, in the case of phosphorus, appear to have set up a nutrient unbalance which diminished yields. Surface application of phosphorus and potash have substantially increased yields. The application of 20# of borax on the surface gave slight increases in yields.

Title: Causes of Red Clover Failures

Leaders: J. G. Leach and E. S. Elliott, Department of Plant Pathology and Bacteriology

The Department of Plant Pathology and Bacteriology has for the past two years made a study of the causes of red clover failure in the north-eastern section of the state. In this region, especially in the South Branch Valley of the Potomac, red clover is an important forage crop and many farmers have been growing the crop for seed. In recent years there have been many red clover failures for which there were no satisfactory explanations. In some cases there have been poor stands and in others, the seed yields have been poor in spite of good stands.

The study which is under way has shown that there are many diseases and insects which contribute to clover failure but most of the trouble has been caused by a relatively new fungus disease, about which very little was known. This disease, called "black patch", was first observed in Kentucky in 1933 where it was considered to be of minor importance and was not studied extensively. Four years later, it was observed in Wisconsin where it was reported as a minor disease that could affect only the leaves, causing little injury. In the South Branch Valley in West Virginia, the disease has been found to be very destructive affecting all parts of the plant, including the leaves, stems, and flowers. By destroying the flowers, this disease has been responsible for great reductions in seed yield in fields that have excellent stands.

Black patch is caused by a fungus, which unlike most fungi, produces no spores. Since no spores are produced to be blown around by wind, the method of spread was not known. The West Virginia studies have shown that the fungus infects the seeds and is seed transmitted. When infected seeds are planted, the seedlings will be killed and the fungus will spread from these infected seedlings to adjacent plants by means of aerial mycelium. One diseased seedling from an infected seed may result in a patch of black diseased plants from which the descriptive name "black patch" is derived.

Preliminary greenhouse experiments show that seed treatment will decrease seedling infection and increase stands but further experiments under field conditions will be necessary before any recommendations for control can be made.

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